



BSI Standards Publication

Semiconductor devices

Part 16-3: Microwave integrated circuits - Frequency converters

National foreword

This British Standard is the UK implementation of EN 60747-16-3:2002+A2:2017. It is identical to IEC 60747-16-3:2002, incorporating amendment 1:2009 and amendment 2:2017. It supersedes BS EN 60747-16-3:2002+A1:2009, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

The UK participation in its preparation was entrusted to Technical Committee EPL/47, Semiconductors.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Semiconductor devices — Part 16-3: Microwave
integrated circuits — Frequency converters (IEC 60747-
16-3:2002/A2:2017)

Dispositifs à semiconducteurs — Partie 16-3:
Circuits intégrés hyperfréquences — Convertisseurs
de fréquence (IEC 60747-16-3:2002/A2:2017)

Halbleiterbauelemente — Teil 16-3: Integrierte
Schaltungen zur Frequenzumsetzung von
Mikrowellen (IEC 60747-16-3:2002/A2:2017)

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European foreword

The text of document 47E/212/FDIS, future edition 1 of IEC 60747-16-3, prepared by SC 47E, Discrete semiconductor devices, of IEC TC 47, Semiconductor device, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60747-16-3 on 2002-07-01.

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Les annexes appelées "normatives" font partie du corps de la norme. Dans la présente norme, l'annexe ZA est normative. L'annexe ZA a été ajoutée par le CENELEC.

Endorsement notice

The text of the International Standard IEC 60747-16-3:2002 was approved by CENELEC as a European Standard without any modification.

Foreword to amendment A1

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Annex ZA has been added by CENELEC.

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Foreword to amendment A2

The text of document 47E/545/CDV, future IEC 60747-16-3:2002/A2, prepared by SC 47E "Discrete semiconductor devices" of IEC/TC 47 "Semiconductor devices" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60747-16-3:2002/A2:2017.

The following dates are fixed:

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2020-09-20

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Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-702	—	International electrotechnical vocabulary (IEV) — Chapter 702: Oscillations, signals and related devices	—	—
IEC 60617-DB	—	Graphical symbols for diagrams	—	—
IEC 60747-1	2006	Semiconductor devices - Part 1: General	—	—
+A1	2010		—	—
IEC 60748-2	1997	Semiconductor devices - Integrated circuits - Part 2: Digital integrated circuits		—
IEC 60748-3	— ¹⁾	Semiconductors devices - Integrated circuits - Part 3: Analogue integrated circuits	—	—
IEC 60748-4	— ¹⁾	Semiconductor devices - Integrated circuits - Part 4: Interface integrated circuits	—	—
IEC 61340-5-1	2007	Electrostatics - Part 5-1: Protection of electronic devices from electrostatic phenomena - General requirements	EN 61340-5-1	2007
IEC/TR 61340-5-2	2007	Electrostatics - Part 5-2: Protection of electronic devices from electrostatic phenomena - User guide	CLC/TR 61340-5-2	2008

¹⁾ Undated reference.

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Semiconductor devices —

Part 16-3: Microwave integrated circuits - Frequency converters

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

1 Scope

This part of IEC 60747 provides new measuring methods, terminology and letter symbols, as well as essential ratings and characteristics for integrated circuit microwave frequency converters.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

^[A2] IEC 60050-702, *International Electrotechnical Vocabulary — Chapter 702: Oscillations, signals and related devices* (available at < <http://www.electropedia.org/> >) ^[A2]

^[A2] IEC 60617, *Graphical symbols for diagrams* (available at < <http://std.iec.ch/iec60617> >) ^[A2]

^[A2] IEC 60747-1:2006, *Semiconductor devices — Part 1: General*
IEC 60747-1:2006/AMD 1:2010 ^[A2]

IEC 60748-2:1997, *Semiconductor devices — Integrated circuits — Part 2: Digital integrated circuits*

IEC 60748-3, *Semiconductor devices — Integrated circuits — Part 3: Analogue integrated circuits*

IEC 60748-4, *Semiconductor devices — Integrated circuits — Part 4: Interface integrated circuits*

^[A1] IEC 61340-5-1:2007, *Electrostatics — Part 5-1: Protection of electronic devices from electrostatic phenomena — General requirements* ^[A1]

^[A1] IEC/TR 61340-5-2:2007, *Electrostatics — Part 5-2: Protection of electronic devices from electrostatic phenomena — User guide* ^[A1]

3 Terms and definitions

For the purpose of this part of IEC 60747, the following terms and definitions apply:

3.1

conversion gain

G_c

ratio of the desired converted output power to the input power

NOTE Usually, the conversion gain is expressed in decibels.

3.2

conversion gain flatness

ΔG_c

difference between the maximum and the minimum conversion gain for a specified input power in a specified frequency range

3.3

LO/RF isolation

$$P_{LO}/P_{LO(RF)}$$

ratio of the incident local power to the local leakage power at the RF port with the IF port terminated in a specified impedance

3.4

LO/IF isolation

$$P_{LO}/P_{LO(IF)}$$

ratio of the incident local power to the local leakage power at the IF port with the RF port terminated in a specified impedance

3.5

RF/IF isolation

$$P_{RF}/P_{RF(IF)}$$

ratio of the incident RF power to the RF feedthrough power at the IF port for a specified local power

NOTE Usually, the RF/IF isolation is applied to the down-converter.

3.6

IF/RF isolation

$$P_{IF}/P_{IF(RF)}$$

ratio of the incident IF power to the IF feedthrough power at the RF port for a specified local power

NOTE Usually, the IF/RF isolation is applied to the up-converter.

3.7

image rejection

$$P_o/P_{o(im)}$$

ratio of the output power when the RF signal is applied, to the output power when the image signal is applied

NOTE Usually, the image rejection is applied to the down-converter.

3.8

sideband suppression

$$P_o/P_{o(U)}$$

ratio of the output power of the desired sideband to the output power of the undesired sideband

NOTE Usually, the sideband suppression is applied to the up-converter.

3.9

LO port return loss

$$L_{ret(LO)}$$

ratio of the specified incident power at the LO port to the reflected power at the LO port, with the RF port and the IF port terminated in each specified impedance

3.10

RF port return loss

$$L_{ret(RF)}$$

ratio of the incident power at the RF port to the reflected power at the RF port for a specified local power, with the IF port terminated in a specified impedance

3.11

IF port return loss

$$L_{ret(IF)}$$

ratio of the incident power at the IF port to the reflected power at the IF port for a specified local power, with the RF port terminated in a specified impedance

3.12

$\overline{A_2}$ output power

P_o

RF power measured at the output port

[SOURCE: IEC 60747-4:2007/AMD1:2017, 7.2.2 $\overline{A_2}$]

3.13

output power at 1-dB conversion compression

$P_{o(1dB)}$

output power where the conversion gain decreases by 1 dB compared with the linear conversion gain

3.14

$\overline{A_1}$ noise figure

F

see 702-08-57 of IEC 60050-702

NOTE The term "noise figure" expresses "noise factor" in decibels. $\overline{A_1}$

3.15

$\overline{A_2}$ intermodulation distortion

P_n / P_1

ratio of the n th order component of the output power to the fundamental component of the output power

NOTE The abbreviation " IMD_n " is in common use for the n th order intermodulation distortion.

[SOURCE: IEC 60747-4:2007/AMD1:2017, 7.2.19 $\overline{A_2}$]

3.16

output power at the intercept point (for intermodulation products)

$P_n(IP)$

output power at the intersection between the extrapolated output powers of the fundamental component and the n th order intermodulation components, when the extrapolation is carried out in a diagram showing the output power of the components (in decibels) as a function of the input power (in decibels)

4 Abbreviated terms

The abbreviations used in this part of IEC 60747 are as follows:

RF	Radio Frequency;
IF	Intermediate Frequency;
LO	Local Oscillator.

5 Essential ratings and characteristics

5.1 General

This clause gives ratings and characteristics required for specifying integrated circuit microwave frequency converters.

5.1.1 Circuit identification and types

5.1.1.1 Designation and types

The identification of type (device name), the category of circuit and technology applied shall be given

Microwave frequency converters are divided into two categories:

- type A: down-converter;
- type B: up-converter.

5.1.1.2 General function description

A general description shall be made of the function performed by the integrated circuit microwave frequency converters and the features for the application.

5.1.1.3 Manufacturing technology

The manufacturing technology, for example, semiconductor monolithic integrated circuit, thin film integrated circuit, micro-assembly, shall be stated. This statement shall include details of the semiconductor technologies such as Schottky-barrier diode, MESFET, Si bipolar transistor, HBT.

5.1.1.4 Package identification

The following shall be stated:

- a) chip or packaged form;
- b) IEC and/or national reference number of the outline drawing, or  *Text deleted*  drawing of non-standard package including terminal numbering;
- c) principal package material, for example, metal, ceramic, plastic;
- d) for chip form: outlines, dimensions, pad sizes, contact material, and recommended contact technologies.

5.1.1.5 Main application

The main application shall be stated if necessary. If the device has restrictive applications, these too shall be stated here.

5.2 Application description

Information on the application of the integrated circuit and its relation to the associated devices shall be given.

5.2.1 Conformance to system and/or interface information

It shall be stated whether the integrated circuit conforms to an application system and/or an interface standard or recommendation.

Detailed information about application systems, equipment and circuits such as VSAT systems, DBS receivers, microwave landing systems shall also be given.

5.2.2 Overall block diagram

A block diagram of the applied systems shall be given if necessary.

5.2.3 Reference data

The most important properties required to permit comparison between derivative types shall be given.

5.2.4 Electrical compatibility

It shall be stated whether the integrated circuit is electrically compatible with other particular integrated circuits or families of integrated circuits, or whether special interfaces are required.

Details shall be given concerning the type of the input and output circuits, for example, input/output impedances, d.c. block, open-drain.

Interchangeability with other devices, if any, shall be given.

5.2.5 Associated devices

If applicable, mention shall be made here of

- devices necessary for correct operation (list with type number, name, and function);
- peripheral devices with direct interfacing (list with type number, name, and function).

5.3 Specification of the function

5.3.1 Detailed block diagram – functional blocks

A detail block diagram or equivalent circuit information of the integrated circuit microwave frequency converters shall be given. The block diagram shall be composed of the following:

- a) functional blocks;
- b) mutual interconnections among the functional blocks;
- c) individual functional units within the functional blocks;
- d) mutual interconnections among the individual functional blocks;
- e) function of each external connection;
- f) interdependence between the separate functional blocks.

The block diagram shall identify the function of each external connection, and, where no ambiguity can arise, it can also show the terminal symbols and/or numbers. If the encapsulation has metallic parts, any connection to them from external terminals shall be indicated. The connections with any associated external electrical elements shall be stated, where necessary.

For the purpose of providing additional information, the complete electrical circuit diagram can be reproduced, though this will not necessarily involve giving indications of the function. Rules governing such diagrams may be obtained from [\[A1\]](#) IEC 60617 [\[A1\]](#).

5.3.2 Identification and function of terminals

All terminals shall be identified on the block diagram (supply terminals, input or output terminals, input/output terminals).

The terminal functions 1) to 4) shall be indicated, as shown in [table 1](#) below.

Table 1 — Function of terminals

Terminal number	Terminal symbol	1 Terminal designation	2 Function	3 Input/output identification	4 Type of input/output circuits