

INTERNATIONAL STANDARD



Semiconductor devices – iTeh Standards
Part 16-3: Microwave integrated circuits – Frequency converters

(<https://standards.iteh.ai>)

Document Preview

[IEC 60747-16-3:2002](#)

<https://standards.iteh.ai/catalog/standards/iec/5aab671-7064-4c3c-9e6b-72f8946afd5f/iec-60747-16-3-2002>





THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2017 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

[IEC 60747-16-3:2002](https://standards.iteh.ai/catalog/standards/iec/5aabd671-7064-4c3c-9e6b-72f8946afd5f/iec-60747-16-3-2002)

<https://standards.iteh.ai/catalog/standards/iec/5aabd671-7064-4c3c-9e6b-72f8946afd5f/iec-60747-16-3-2002>



IEC 60747-16-3

Edition 1.2 2017-08
CONSOLIDATED VERSION

INTERNATIONAL STANDARD



Semiconductor devices – iTeh Standards
Part 16-3: Microwave integrated circuits – Frequency converters

(<https://standards.iteh.ai>)
Document Preview

IEC 60747-16-3:2002

<https://standards.iteh.ai/catalog/standards/iec/5aab671-7064-4c3c-9e6b-72f8946afd5f/iec-60747-16-3-2002>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.080.99

ISBN 978-2-8322-4749-5

Warning! Make sure that you obtained this publication from an authorized distributor.

REDLINE VERSION



Semiconductor devices – iTeh Standards
Part 16-3: Microwave integrated circuits – Frequency converters
(<https://standards.iteh.ai>)
Document Preview

[IEC 60747-16-3:2002](#)

<https://standards.iteh.ai/catalog/standards/iec/5aabd671-7064-4c3c-9e6b-72f8946afd5f/iec-60747-16-3-2002>



CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	7
4 Abbreviated terms	8
5 Essential ratings and characteristics.....	9
5.1 General	9
5.2 Application description	9
5.3 Specification of the function	10
5.4 Limiting values (absolute maximum rating system)	12
5.5 Operating conditions (within the specified operating temperature range)	14
5.6 Electrical characteristics.....	14
5.7 Mechanical and environmental ratings, characteristics and data.....	15
5.8 Additional information.....	15
6 Measuring methods	16
6.1 General	16
6.2 Conversion gain (G_c).....	17
6.3 Conversion gain flatness (ΔG_c).....	19
6.4 LO/IF isolation ($P_{LO} / P_{LO(IF)}$)	21
6.5 LO/RF isolation ($P_{LO} / P_{LO(RF)}$).....	22
6.6 RF/IF, IF/RF isolation	24
6.7 Image rejection ($P_o / P_{o(im)}$).....	28
6.8 Sideband suppression ($P_o / P_{o(U)}$)	29
6.9 Output power (P_o)	31
6.10 Output power at 1-dB conversion compression ($P_{o(1dB)}$).....	32
6.11 Noise figure (F)	33
6.12 Intermodulation distortion (P_n/P_1)	35
6.13 Output power at the intercept point (for intermodulation products) ($P_{n(IP)}$)	38
6.14 LO port return loss ($L_{ret(LO)}$)	39
6.15 RF port return loss ($L_{ret(RF)}$)	40
6.16 IF port return loss ($L_{ret(IF)}$).....	42
Bibliography.....	44
Figure 1 – Electrical terminal symbols.....	11
Figure 2 – Circuit diagram for the measurement of conversion gain	17
Figure 3 – Circuit diagram for the measurement of the LO/IF isolation	21
Figure 4 – Circuit diagram for the measurement of the LO/RF isolation.....	23
Figure 5 – Circuit diagram for the measurement of the RF/IF isolation for type A	24
Figure 6 – Circuit diagram for the measurement of the RF/IF IF/RF isolation for type B	26
Figure 7 – Circuit diagram for measurement of noise figure	33
Figure 8 – Circuit for the measurement of intermodulation distortion	36
Figure 9 – Circuit for the measurement of the LO port return loss	39
Figure 10 – Circuit for the measurement of the RF/IF port return loss	41

Table 1 – Function of terminals.....	11
Table 2 – Electrical limiting values.....	13
Table 3 – Electrical characteristics.....	15

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 60747-16-3:2002](https://standards.iteh.ai/catalog/standards/iec/5aab671-7064-4c3c-9e6b-72f8946afd5f/iec-60747-16-3-2002)

<https://standards.iteh.ai/catalog/standards/iec/5aab671-7064-4c3c-9e6b-72f8946afd5f/iec-60747-16-3-2002>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This consolidated version of the official IEC Standard and its amendments has been prepared for user convenience.

IEC 60747-16-3 edition 1.2 contains the first edition (2002-05) [documents 47E/212/FDIS and 47E/219/RVD], its amendment 1 (2009-03) [documents 47E/357/CDV and 47E/372/RVC] and its amendment 2 (2017-08) [documents 47E/545/CDV and 47E/562/RVC].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 60747-16-3 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

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.

IMPORTANT – The “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 60747-16-3:2002](#)

<https://standards.iteh.ai/catalog/standards/iec/5aab671-7064-4c3c-9e6b-72f8946afd5f/iec-60747-16-3-2002>

SEMICONDUCTOR DEVICES –**Part 16-3: Microwave integrated circuits –
Frequency converters****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.

~~IEC 60050-702:1992, International Electrotechnical Vocabulary – Chapter 702: Oscillations, signals and related devices~~

~~IEC 60617-12, Graphical symbols for diagrams – Part 12: Binary logic elements~~

~~IEC 60617-13, Graphical symbols for diagrams – Part 13: Analogue elements~~

~~IEC 60747-1:1983, Semiconductor devices – Discrete devices and integrated circuits – Part 1: General~~

IEC 60747-16-3:2002

~~IEC 60747-16-1:2001, Semiconductor devices – Part 16-1: Microwave integrated circuits – 2002 Amplifiers – Amendment 1 (2007)⁴~~

IEC 60050-702, International Electrotechnical Vocabulary – Chapter 702: Oscillations, signals and related devices (available at < <http://www.electropedia.org/>>)

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

IEC 60747-1:2006, Semiconductor devices – Part 1: General

IEC 60747-1:2006/AMD 1:2010

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

⁴ ~~There exists a consolidated edition 1.1 published in 2007, including the base publication (2001) and its Amendment 1 (2007).~~

IEC 61340-5-1:2007, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*

IEC/TR 61340-5-2:2007, *Electrostatics – Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide*

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

output power

P_o

see IEC 60747-16-2, 3.3² RF power measured at the output port

[SOURCE: IEC 60747-4:2007/AMD1:2017, 7.2.2]

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

noise figure, F

see IEC 60747-1 Chapter IV, 5.4.4 see 702-08-57 of IEC 60050-702

NOTE The term "noise figure" expresses "noise factor" in decibels.

3.15

intermodulation distortion

P_n/P_1

ratio of the output power of the n th order component to the output power of the fundamental component, at a specified input power

see 3.7 of Amendment 1 of IEC 60747-16-1

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]

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:

² IEC 60747-16-2:2001, *Semiconductor devices—Part 16-2: Microwave integrated circuits—Frequency prescalers*

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 ~~of~~-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 ~~IEC 60617-12 or IEC 60617-13~~ IEC 60617.