

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Semiconductor devices –
Part 16-6: Microwave integrated circuits – Frequency multipliers**

**Dispositifs à semiconducteurs –
Partie 16-6: Circuits intégrés hyperfréquences – Multiplicateurs de fréquence**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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

Tel.: +41 22 919 02 11
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

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 It also gives information on projects, replaced and withdrawn publications.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 once a month by email.

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: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries 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

67 000 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.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Semiconductor devices –
Part 16-6: Microwave integrated circuits – Frequency multipliers**

**Dispositifs à semiconducteurs –
Partie 16-6: Circuits intégrés hyperfréquences – Multiplicateurs de fréquence**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.080.99

ISBN 978-2-8322-7081-3

Warning! Make sure that you obtained this publication from an authorized distributor. Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.
--

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Essential ratings and characteristics.....	8
4.1 General requirements	8
4.1.1 Circuit identification and types	8
4.1.2 General function description	8
4.1.3 Manufacturing technology	8
4.1.4 Package identification.....	8
4.2 Application description	8
4.2.1 Conformance to system and/or interface information	8
4.2.2 Overall block diagram	8
4.2.3 Reference data	8
4.2.4 Electrical compatibility	8
4.2.5 Associated devices	9
4.3 Specification of the function	9
4.3.1 Detailed block diagram – Functional blocks	9
4.3.2 Identification and function of terminals.....	9
4.3.3 Function description	10
4.4 Limiting values (absolute maximum rating system).....	10
4.4.1 Requirements	10
4.4.2 Electrical limiting values	10
4.4.3 Temperatures	11
4.5 Operating conditions (within the specified operating temperature range).....	11
4.6 Electrical characteristics	12
4.7 Mechanical and environmental ratings, characteristics and data	12
4.8 Additional information	12
5 Measuring methods	13
5.1 General.....	13
5.1.1 General precautions	13
5.1.2 Characteristic impedance	13
5.1.3 Handling precautions	13
5.1.4 Types	13
5.2 Output power (P_O).....	13
5.2.1 Purpose	13
5.2.2 Circuit diagram	13
5.2.3 Principle of measurement	13
5.2.4 Circuit description and requirements.....	14
5.2.5 Precautions to be observed	14
5.2.6 Measurement procedure	14
5.2.7 Specified conditions.....	14
5.3 Conversion gain (G_C)	14
5.3.1 Purpose	14
5.3.2 Circuit diagram	15
5.3.3 Principle of measurement	15
5.3.4 Circuit description and requirements.....	15

5.3.5	Precautions to be observed	15
5.3.6	Measurement procedure	15
5.3.7	Specified conditions.....	15
5.4	Input return loss ($L_{\text{ret(in)}}$)	15
5.4.1	Purpose	15
5.4.2	Circuit diagram	15
5.4.3	Principle of measurement	16
5.4.4	Circuit description and requirements.....	16
5.4.5	Precautions to be observed	16
5.4.6	Measurement procedure	16
5.4.7	Specified conditions.....	17
5.5	Output return loss ($L_{\text{ret(out)}}$)	17
5.5.1	Purpose	17
5.5.2	Circuit diagram	17
5.5.3	Principle of measurement	17
5.5.4	Circuit description and requirements.....	18
5.5.5	Precautions to be observed	18
5.5.6	Measurement procedure	18
5.5.7	Specified conditions.....	18
5.6	Fundamental isolation (P_O/P_1)	19
5.6.1	Purpose	19
5.6.2	Circuit diagram	19
5.6.3	Principle of measurement	19
5.6.4	Circuit description and requirements.....	19
5.6.5	Precautions to be observed	19
5.6.6	Measurement procedure	19
5.6.7	Specified conditions.....	20
5.7	n-th order harmonic isolation (P_O/P_{nth})	20
5.7.1	Purpose	20
5.7.2	Circuit diagram	20
5.7.3	Principle of measurement	20
5.7.4	Circuit description and requirements.....	20
5.7.5	Precautions to be observed	20
5.7.6	Measurement procedure	20
5.7.7	Specified conditions.....	21
5.8	Phase noise ($\mathcal{S}(f)$)	21
5.8.1	Purpose	21
5.8.2	Measuring methods	21
Figure 1 – Circuit diagram for the measurement of the output power.....		13
Figure 2 – Circuit diagram for the measurement of the input return loss.....		16
Figure 3 – Circuit diagram for the measurement of the output return loss.....		17
Figure 4 – Circuit diagram for the measurement of the phase noise $\mathcal{S}(f)$ (method 1)		22
Figure 5 – Circuit diagram for the measurement of the phase noise $\mathcal{S}(f)$ (method 2)		23
Figure 6 – Circuit diagram for the measurement of the phase noise $\mathcal{S}(f)$ (method 3)		24
Table 1 – Comparison of phase noise measuring methods.....		21

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES –**Part 16-6: Microwave integrated circuits –
Frequency multipliers****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.

International Standard IEC 60747-16-6 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

The text of this International Standard is based on the following documents:

CDV	Report on voting
47E/602/CDV	47E/622A/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60747 series, published under the general title *Semiconductor devices*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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

SEMICONDUCTOR DEVICES –

Part 16-6: Microwave integrated circuits – Frequency multipliers

1 Scope

This part of IEC 60747 specifies the terminology, essential ratings and characteristics, and measuring methods of microwave integrated circuit frequency multipliers.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 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 60747-4, *Semiconductor devices – Discrete devices – Part 4: Microwave diodes and transistors*

IEC 60747-16-3:2002, *Semiconductor devices – Part 16-3: Microwave integrated circuits – Frequency converters*
IEC 60747-16-3:2002/AMD 1:2009
IEC 60747-16-3:2002/AMD 2:2017

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

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

output frequency

f_o

frequency which equals the input frequency multiplied by the multiplying factor N , where N is an integer