IEC 60747-16-5

Edition 1.0 2013-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Semiconductor devices –
Part 16-5: Microwave integrated circuits – Oscillators

Dispositifs à semiconducteurs –
Partie 16-5: Circuits intégrés hyperfréquences – Oscillateurs

IEC 60747-16-5:2013

IEC Central Office
3, rue de Varembé
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.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you 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It also gives information on projects, replaced and withdrawn publications.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 on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

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.

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) 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 CEI

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

Liens utiles:

Recherche de publications CEI - www.iec.ch/searchpub

La recherche avancée vous permet de trouver des publications CEI 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.

Just Published CEI - webstore.iec.ch/justpublished

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

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - webstore.iec.ch/csc

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

IEC 60747-16-5

Edition 1.0 2013-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Semiconductor devices – Part 16-5: Microwave integrated circuits – Oscillators

Dispositifs à semiconducteurs – Partie 16-5: Circuits intégrés hyperfréquences – Oscillateurs

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX X

ICS 31.080.99

ISBN 978-2-83220-827-4

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES –

Part 16-5: Microwave integrated circuits – Oscillators

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 60747-16-5 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

The text of this standard is based on the following documents:

FDIS	Report on voting
47E/452/FDIS	47E/454/RVD

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

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

A list of all parts of 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 publication will remain unchanged until the stability 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.

SEMICONDUCTOR DEVICES –

Part 16-5: Microwave integrated circuits – Oscillators

1 Scope

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

This standard is applicable to the fixed and voltage-controlled semiconductor microwave oscillator devices, except the oscillator modules such as synthesizers which require external controllers.

NOTE This document is not applicable to the quartz crystal controlled oscillators. They are specified by IEC 60679-1.

2 Normative references

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.

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

IEC 60747-1:2006, *Semiconductor devices – Part 1: General* [1)]
Amendment 1:2010

IEC 60747-4:2007, *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* [2)]
Amendment 1:2009

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

3.1
oscillation frequency
f_{osc}
frequency measured at the output port

---

1) A consolidated edition (2010) exists, including IEC 60747-1:2006 and its Amendment 1.

2) A consolidated edition (2010) exists, including IEC 60747-16-3:2002 and its Amendment 1.

3.2
output power
$P_{o,osc}$
power measured at the output port

3.3
phase noise
$\mathscr{L}(f)$
frequency-domain measure of the short-term frequency stability of an oscillator, normally expressed as the power spectral density of the phase fluctuations, $S_\varphi(f)$, where the phase fluctuation function is $\varphi(t) = 2\pi\, Ft\text{-}2\pi F_0 t$

Note 1 to entry: The spectral density of phase fluctuation can be directly related to the spectral density of frequency fluctuation by

$$S_\varphi(f) = \left(\frac{F_0}{f}\right)^2 S_y(f)\,\text{rad}^2/\text{Hz}$$

where

F is the oscillator frequency;

F_0 is the average oscillator frequency;

f is the Fourier frequency.

Note 2 to entry: $\mathscr{L}(f)$ is pronounced "script-ell of f".

[SOURCE: IEC 60679-1:2007, 3.2.25, modified – A symbol and two notes have been added. The explanation of the spectral density of phase fluctuation has been moved to a note]

3.4
tuning sensitivity
$S_{f,v}$
ratio of the change of oscillation frequency to the variation of the control voltage

3.5
frequency pushing
$f_{osc,push}$
change of the oscillation frequency with the variation of the bias voltage

3.6
frequency pulling
$f_{osc,pull}$
change of the oscillation frequency with all phase angles for constant load reflection coefficient

3.7
n-th order harmonic distortion ratio
P_{nth}/P_1
ratio of the power of the n-th order harmonic component at the output port to the output power at the oscillation frequency

3.8
oscillation frequency range
difference between the oscillation frequencies at the maximum control voltage and at the minimum control voltage

3.9
output power flatness
$\Delta P_{o,osc}$
difference between the maximum and the minimum output power within the control voltage range

3.10
tuning linearity
ratio of the maximum departure of the oscillation frequency from an ideal straight line between its values at the minimum and maximum control voltages to the oscillation frequency range

3.11
oscillation frequency temperature coefficient
$\alpha_{f,temp}$
ratio of the change in oscillation frequency to the corresponding change in temperature

3.12
output power temperature coefficient
$\alpha_{P_i,temp}$
ratio of the change in output power to the corresponding change in temperature

3.13
spurious distortion ratio
P_s/P_1
ratio of the power of the maximum spurious component at the output port to the output power at the oscillation frequency

3.14
load mismatch tolerance
Ψ_L

maximum load VSWR (voltage standing-wave ratio) in the range where the device oscillates with no unexpected spurious intensity and/or no discontinuity of frequency tuning characteristics (in case of VCO) at all phase angles

3.15
load mismatch ruggedness
Ψ_R
maximum load VSWR in the range where the device withstand load mismatch with no degradation at all phase angles with specified conditions

[SOURCE: IEC 60747-4:2007, 7.2.22]

3.16
modulation bandwidth
B_{mod}
modulating frequency at which the frequency deviation decreases by 3 dB from its dc value

3.17
sensitivity flatness
ratio of the maximum departure of the tuning sensitivity from an ideal straight line between its values at the minimum and maximum control voltages to the oscillation frequency range

4 Essential ratings and characteristics

4.1 General requirements

4.1.1 Circuit identification and types

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

Microwave oscillators are divided into two categories:

– type A: fixed oscillator;
– type B: voltage controlled oscillator.

4.1.2 General function description

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

4.1.3 Manufacturing technology

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

IEC 60747-4 shall be referred to for terminology and letter symbols, essential ratings and characteristics and measuring methods of such microwave devices.

4.1.4 Package identification

The following statements shall be made:

a) chip or packaged form;
b) IEC and/or national reference number of the outline drawing, or drawing of non-standard package including terminal numbering;
c) principal package material, for example, metal, ceramic, plastic.

4.2 Application description

4.2.1 Conformance to system and/or interface information

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

Detailed information concerning application systems, equipment and circuits such as very small aperture terminal (VSAT) systems, broadcasting satellite (BS) receivers, microwave landing systems, etc. should also be given.

4.2.2 Overall block diagram

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

4.2.3 Reference data

The most important properties that permit comparison between derivative types should be given.

4.2.4 Electrical compatibility

It should 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 should be given concerning the type of output circuits, e.g. output impedances, d.c. block, open-drain, etc. Interchangeability with other devices, if any, should also be given.

4.2.5 Associated devices

If applicable, the following should be stated:

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

4.3 Specification of the function

4.3.1 Detailed block diagram – Functional blocks

A detail block diagram or equivalent circuit information of the integrated circuit microwave oscillators 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) inter-dependence between the separate functional blocks.

The block diagram shall identify the function of each external connection and, where no ambiguity can arise, 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.

As additional information, the complete electrical circuit diagram can be reproduced, but not necessarily with indications of the values of the circuit components. The graphical symbol for the function shall be given. Rules governing such diagrams may be obtained from IEC 60617.

4.3.2 Identification and function of terminals

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

The terminal functions 1) to 4) shall be indicated in a table as follows:

Terminal number	Terminal symbol	1) Terminal designation	2) Function	Function of terminal	
				3) Output identification	4) Type of output circuits

(1) Terminal designation

A terminal designation to indicate the function of the terminal shall be given. Supply terminals, ground terminals, blank terminals (with abbreviation NC), non-usable terminals (with abbreviation NU) shall be distinguished.

(2) Function

A brief indication of the terminal function shall be given:

– each function of multi-role terminals, i.e. terminals having multiple functions;

– each function of integrated circuit selected by mutual pin connections, programming and/or application of function selection data to the function selection pin, such as mode selection pin.

(3) Output identification

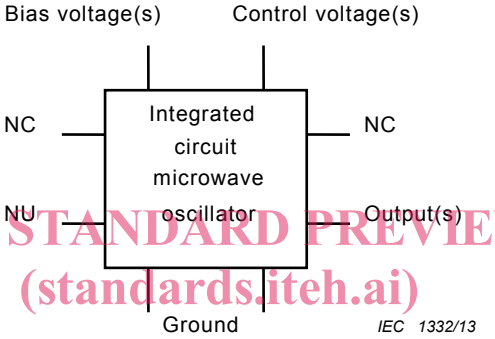
Output and multiplex output terminals shall be distinguished.

(4) Type of output circuits

The type of output circuit, e.g. output impedances, with or without d.c. block, etc., shall be distinguished.

If the baseplate of the package is used as a ground terminal, the type of ground, e.g. analog ground, digital ground, shall be stated in the column of 2) Function.

EXAMPLE



4.3.3 Function description

The function performed by the circuit shall be specified, including the following information:

– basic function;
– relation to external terminals;
– operation mode (e.g., set-up method, preference, etc.).

4.4 Limiting values (absolute maximum rating system)

4.4.1 Requirements

The table for these values shall contain the following:

– Any interdependence of limiting conditions shall be specified.
– If externally connected and/or attached elements, for example heatsinks, have an influence on the values of the ratings, the ratings shall be prescribed for the integrated circuit with the elements connected and/or attached.
– If limiting values are exceeded for transient overload, the permissible excess and their durations shall be specified.
– Where minimum and maximum values differ during programming of the device, this shall be stated.
– All voltages are referenced to a specified reference terminal (V_{SS}, ground, etc.).
– In satisfying the following clauses, if maximum and/or minimum values are quoted, the manufacturer shall indicate whether he refers to the absolute magnitude or to the algebraic value of the quantity.