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

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SEMICONDUCTOR DEVICES –

Part 16-5: Microwave integrated circuits – Oscillators

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IEC 60747-16-5 edition 1.1 contains the first edition (2013-06) [documents 47E/452/FDIS and 47E/454/RVD] and its amendment 1 (2020-07) [documents 47E/673/CDV and 47E/705/RVC] and its corrigendum (2020-09).

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. 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 60747-16-5 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

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 the base publication and its amendment 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- withdrawn,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.

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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 60747-4:2007/AMD 1:2017

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

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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 Terms and definitions

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

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 $\varphi(t) = 2\pi Ft - 2\pi F_0 t$~~

~~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]~~

$\mathscr{L}(f)$
frequency-domain measure of the short-term frequency stability of an oscillator

Note 1 to entry: This phase noise is normally expressed as the power spectral density of the phase fluctuations, $S_\phi(f)$, where the phase fluctuation function is $\phi(t)=2\pi Ft-2\pi F_0 t$. The spectral density of phase fluctuation can be directly related to the spectral density of frequency fluctuation by the following formula:

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

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 60050-561:2014, 561-03-22, modified – A symbol and Note 2 to entry have been added.]

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
$\alpha_{P,temp}$
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~~

ψ_L
maximum load VSWR 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

Note 1 to entry: "VSWR" is an abbreviation of "voltage standing wave ratio".

Note 2 to entry: "VCO" is an abbreviation of "voltage controlled oscillator".

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.