IEC 60747-16-5

Edition 1.1 2020-07
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

colour
inside

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.080.99

ISBN 978-2-8322-8681-4

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

® Registered trademark of the International Electrotechnical Commission

IEC 60747-16-5

Edition 1.1 2020-07

REDLINE VERSION

colour
inside

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

IEC 60747-16-5:2013-06+AMD1:2020-07 CSV(en)

CONTENTS

FOREWORD 6
1 Scope 8
2 Normative references 8
3 Terms and definitions 9
4 Essential ratings and characteristics 11
  4.1 General requirements 11
    4.1.1 Circuit identification and types 11
    4.1.2 General function description 11
    4.1.3 Manufacturing technology 11
    4.1.4 Package identification 12
  4.2 Application description 12
    4.2.1 Conformance to system and/or interface information 12
    4.2.2 Overall block diagram 12
    4.2.3 Reference data 12
    4.2.4 Electrical compatibility 12
    4.2.5 Associated devices 12
  4.3 Specification of the function 12
    4.3.1 Detailed block diagram – Functional blocks 12
    4.3.2 Identification and function of terminals 13
    4.3.3 Function description 14
  4.4 Limiting values (absolute maximum rating system) 14
    4.4.1 Requirements 14
    4.4.2 Electrical limiting values 14
    4.4.3 Temperatures 15
  4.5 Operating conditions (within the specified operating temperature range) 15
  4.6 Electrical characteristics 16
  4.7 Mechanical and environmental ratings, characteristics and data 16
  4.8 Additional information 17
5 Measuring methods 17
  5.1 General 17
    5.1.1 General precautions 17
    5.1.2 Characteristic impedance 17
    5.1.3 Handling precautions 17
    5.1.4 Types 17
  5.2 Oscillation frequency (f_{osc}) 17
    5.2.1 Purpose 17
    5.2.2 Circuit diagram 18
    5.2.3 Principle of measurement 18
    5.2.4 Circuit description and requirements 18
    5.2.5 Precautions to be observed 18
    5.2.6 Measurement procedure 18
    5.2.7 Specified conditions 18
  5.3 Output power ($P_{\text{o,osc}}$) 18
    5.3.1 Purpose 18
    5.3.2 Circuit diagram 19
    5.3.3 Principle of measurement 19

5.3.4 Circuit description and requirements 19
5.3.5 Precautions to be observed 19
5.3.6 Measurement procedure 19
5.3.7 Specified conditions 19
5.4 Phase noise ($\mathscr{L}(f)$) 19
5.4.1 Purpose 19
5.4.2 Measuring methods 19
5.5 Tuning sensitivity ($S_{\mathrm{f,v}}$) 24
5.5.1 Purpose 24
5.5.2 Circuit diagram 24
5.5.3 Principle of measurement 24
5.5.4 Circuit description and requirements 25
5.5.5 Precautions to be observed 25
5.5.6 Measurement procedure 25
5.5.7 Specified conditions 25
5.6 Frequency pushing ($f_{\mathrm{osc,push}}$) 25
5.6.1 Purpose 25
5.6.2 Circuit diagram 25
5.6.3 Principle of measurement 25
5.6.4 Circuit description and requirements 25
5.6.5 Precautions to be observed 25
5.6.6 Measurement procedure 25
5.6.7 Specified conditions 26
5.7 Frequency pulling ($f_{\mathrm{osc,pull}}$) 26
5.7.1 Purpose 26
5.7.2 Circuit diagram 26
5.7.3 Principle of measurement 26
5.7.4 Circuit description and requirements 27
5.7.5 Precautions to be observed 27
5.7.6 Measurement procedure 27
5.7.7 Specified conditions 27
5.8 n-th order harmonic distortion ratio (P_{nth}/P_1) 27
5.8.1 Purpose 27
5.8.2 Circuit diagram 27
5.8.3 Principle of measurement 27
5.8.4 Circuit description and requirements 28
5.8.5 Measurement procedure 28
5.8.6 Specified conditions 28
5.9 Output power flatness ($\Delta P_{\mathrm{o,osc}}$) 28
5.9.1 Purpose 28
5.9.2 Circuit diagram 29
5.9.3 Principle of measurement 29
5.9.4 Circuit description and requirements 29
5.9.5 Precautions to be observed 29
5.9.6 Measurement procedure 29
5.9.7 Specified conditions 29
5.10 Tuning linearity 29
5.10.1 Purpose 29
5.10.2 Circuit diagram 29

5.10.3 Principle of measurement 29
5.10.4 Circuit description and requirements 30
5.10.5 Precautions to be observed 30
5.10.6 Measurement procedure 30
5.10.7 Specified conditions 31
5.11 Frequency temperature coefficient ($\alpha_{\mathrm{f,temp}}$) 31
5.11.1 Purpose 31
5.11.2 Circuit diagram 31
5.11.3 Principle of measurement 31
5.11.4 Circuit description and requirements 32
5.11.5 Precautions to be observed 32
5.11.6 Measurement procedure 32
5.11.7 Specified conditions 32
5.12 Output power temperature coefficient ($\alpha_{\mathrm{P,temp}}$) 32
5.12.1 Purpose 32
5.12.2 Circuit diagram 32
5.12.3 Principle of measurement 32
5.12.4 Circuit description and requirements 33
5.12.5 Precautions to be observed 33
5.12.6 Measurement procedure 33
5.12.7 Specified conditions 33
5.13 Spurious distortion ratio (P_{s}/P_1) 33
5.13.1 Purpose 33
5.13.2 Circuit diagram 33
5.13.3 Principle of measurement 33
5.13.4 Circuit description and requirements 34
5.13.5 Measurement procedure 34
5.13.6 Specified conditions 34
5.14 Modulation bandwidth (B_{mod}) 34
5.14.1 Purpose 34
5.14.2 Circuit diagram 34
5.14.3 Principle of measurement 35
5.14.4 Circuit description and requirements 35
5.14.5 Precautions to be observed 36
5.14.6 Measurement procedure 36
5.14.7 Specified conditions 36
5.15 Sensitivity flatness 36
5.15.1 Purpose 36
5.15.2 Circuit diagram 36
5.15.3 Principle of measurement 36
5.15.4 Circuit description and requirements 37
5.15.5 Precautions to be observed 37
5.15.6 Measurement procedure 37
5.15.7 Specified conditions 38
6 Verifying methods 38
6.1 Load mismatch tolerance (Ψ_{L}) 38
6.1.1 Purpose 38
6.1.2 Verifying method 1 (spurious intensity) 38

6.1.3 Verifying method 2 (no discontinuity of frequency tuning characteristics of VCO) 39
6.2 Load mismatch ruggedness (Ψ_R) 39
6.2.1 Purpose 39
6.2.2 Circuit diagram 39
6.2.3 Circuit description and requirements 39
6.2.4 Precautions to be observed 40
6.2.5 Test Procedure 40
6.2.6 Specified conditions 40
Bibliography 41

Figure 1 – Circuit diagram for the measurement of the oscillation frequency f_{osc} 18
Figure 2 – Circuit diagram for the measurement of the phase noise $\mathscr{L}(f)$ (method 1) 20
Figure 3 – Circuit diagram for the measurement of the phase noise $\mathscr{L}(f)$ (method 2) 22
Figure 4 – Circuit diagram for the measurement of the phase noise $\mathscr{L}(f)$ (method 3) 23
Figure 5 – Circuit diagram for the measurement of the frequency pulling $f_{osc,pull}$ 26
Figure 6 – Tuning linearity 30
Figure 7 – Circuit diagram for the measurement of the oscillation frequency temperature coefficient $\alpha_{f,temp}$ 31
Figure 8 – Circuit diagram for the measurement of the modulation bandwidth B_{mod} 35
Figure 9 – Sensitivity flatness 37

Table 1 – Comparison of phase noise measuring methods 20

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.

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

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].

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.

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 document using a colour printer.

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*

---

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.~~

IEC 60747-16-5

Edition 1.1 2020-07

FINAL VERSION

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

IEC 60747-16-5:2013-06+AMD1:2020-07 CSV(en)

CONTENTS

FOREWORD 6

1 Scope 8

2 Normative references 8

3 Terms and definitions 9

4 Essential ratings and characteristics 11

- 4.1 General requirements 11
  - 4.1.1 Circuit identification and types 11
  - 4.1.2 General function description 11
  - 4.1.3 Manufacturing technology 11
  - 4.1.4 Package identification 11
- 4.2 Application description 11
  - 4.2.1 Conformance to system and/or interface information 11
  - 4.2.2 Overall block diagram 11
  - 4.2.3 Reference data 12
  - 4.2.4 Electrical compatibility 12
  - 4.2.5 Associated devices 12
- 4.3 Specification of the function 12
  - 4.3.1 Detailed block diagram – Functional blocks 12
  - 4.3.2 Identification and function of terminals 12
  - 4.3.3 Function description 13
- 4.4 Limiting values (absolute maximum rating system) 13
  - 4.4.1 Requirements 13
  - 4.4.2 Electrical limiting values 14
  - 4.4.3 Temperatures 14
- 4.5 Operating conditions (within the specified operating temperature range) 15
- 4.6 Electrical characteristics 15
- 4.7 Mechanical and environmental ratings, characteristics and data 16
- 4.8 Additional information 16

5 Measuring methods 16

- 5.1 General 16
  - 5.1.1 General precautions 16
  - 5.1.2 Characteristic impedance 17
  - 5.1.3 Handling precautions 17
  - 5.1.4 Types 17
- 5.2 Oscillation frequency (f_{osc}) 17
  - 5.2.1 Purpose 17
  - 5.2.2 Circuit diagram 17
  - 5.2.3 Principle of measurement 17
  - 5.2.4 Circuit description and requirements 17
  - 5.2.5 Precautions to be observed 18
  - 5.2.6 Measurement procedure 18
  - 5.2.7 Specified conditions 18
- 5.3 Output power ($P_{\text{o,osc}}$) 18
  - 5.3.1 Purpose 18
  - 5.3.2 Circuit diagram 18
  - 5.3.3 Principle of measurement 18

5.3.4 Circuit description and requirements 18
5.3.5 Precautions to be observed 18
5.3.6 Measurement procedure 18
5.3.7 Specified conditions 19
5.4 Phase noise ($\mathscr{L}(f)$) 19
5.4.1 Purpose 19
5.4.2 Measuring methods 19
5.5 Tuning sensitivity ($S_{\mathrm{f,v}}$) 24
5.5.1 Purpose 24
5.5.2 Circuit diagram 24
5.5.3 Principle of measurement 24
5.5.4 Circuit description and requirements 24
5.5.5 Precautions to be observed 24
5.5.6 Measurement procedure 24
5.5.7 Specified conditions 24
5.6 Frequency pushing ($f_{\mathrm{osc,push}}$) 24
5.6.1 Purpose 24
5.6.2 Circuit diagram 25
5.6.3 Principle of measurement 25
5.6.4 Circuit description and requirements 25
5.6.5 Precautions to be observed 25
5.6.6 Measurement procedure 25
5.6.7 Specified conditions 25
5.7 Frequency pulling ($f_{\mathrm{osc,pull}}$) 25
5.7.1 Purpose 25
5.7.2 Circuit diagram 25
5.7.3 Principle of measurement 26
5.7.4 Circuit description and requirements 26
5.7.5 Precautions to be observed 26
5.7.6 Measurement procedure 26
5.7.7 Specified conditions 27
5.8 n-th order harmonic distortion ratio (P_{nth}/P_1) 27
5.8.1 Purpose 27
5.8.2 Circuit diagram 27
5.8.3 Principle of measurement 27
5.8.4 Circuit description and requirements 27
5.8.5 Measurement procedure 27
5.8.6 Specified conditions 28
5.9 Output power flatness ($\Delta P_{\mathrm{o,osc}}$) 28
5.9.1 Purpose 28
5.9.2 Circuit diagram 28
5.9.3 Principle of measurement 28
5.9.4 Circuit description and requirements 28
5.9.5 Precautions to be observed 28
5.9.6 Measurement procedure 28
5.9.7 Specified conditions 28
5.10 Tuning linearity 29
5.10.1 Purpose 29
5.10.2 Circuit diagram 29

5.10.3 Principle of measurement 29
5.10.4 Circuit description and requirements 29
5.10.5 Precautions to be observed 30
5.10.6 Measurement procedure 30
5.10.7 Specified conditions 30
5.11 Frequency temperature coefficient ($\alpha_{\mathrm{f,temp}}$) 30
5.11.1 Purpose 30
5.11.2 Circuit diagram 30
5.11.3 Principle of measurement 31
5.11.4 Circuit description and requirements 31
5.11.5 Precautions to be observed 31
5.11.6 Measurement procedure 31
5.11.7 Specified conditions 31
5.12 Output power temperature coefficient ($\alpha_{\mathrm{P,temp}}$) 31
5.12.1 Purpose 31
5.12.2 Circuit diagram 31
5.12.3 Principle of measurement 32
5.12.4 Circuit description and requirements 32
5.12.5 Precautions to be observed 32
5.12.6 Measurement procedure 32
5.12.7 Specified conditions 32
5.13 Spurious distortion ratio (P_{S}/P_1) 32
5.13.1 Purpose 32
5.13.2 Circuit diagram 33
5.13.3 Principle of measurement 33
5.13.4 Circuit description and requirements 33
5.13.5 Measurement procedure 33
5.13.6 Specified conditions 33
5.14 Modulation bandwidth (B_{mod}) 33
5.14.1 Purpose 33
5.14.2 Circuit diagram 33
5.14.3 Principle of measurement 34
5.14.4 Circuit description and requirements 34
5.14.5 Precautions to be observed 35
5.14.6 Measurement procedure 35
5.14.7 Specified conditions 35
5.15 Sensitivity flatness 35
5.15.1 Purpose 35
5.15.2 Circuit diagram 35
5.15.3 Principle of measurement 35
5.15.4 Circuit description and requirements 36
5.15.5 Precautions to be observed 36
5.15.6 Measurement procedure 36
5.15.7 Specified conditions 37
6 Verifying methods 37
6.1 Load mismatch tolerance (Ψ_{L}) 37
6.1.1 Purpose 37
6.1.2 Verifying method 1 (spurious intensity) 37

6.1.3 Verifying method 2 (no discontinuity of frequency tuning characteristics of VCO) 38
6.2 Load mismatch ruggedness (Ψ_{R}) 38
6.2.1 Purpose 38
6.2.2 Circuit diagram 38
6.2.3 Circuit description and requirements 38
6.2.4 Precautions to be observed 39
6.2.5 Test Procedure 39
6.2.6 Specified conditions 39
Bibliography 40

Figure 1 – Circuit diagram for the measurement of the oscillation frequency f_{osc} 17
Figure 2 – Circuit diagram for the measurement of the phase noise $\mathscr{L}(f)$ (method 1) 20
Figure 3 – Circuit diagram for the measurement of the phase noise $\mathscr{L}(f)$ (method 2) 21
Figure 4 – Circuit diagram for the measurement of the phase noise $\mathscr{L}(f)$ (method 3) 22
Figure 5 – Circuit diagram for the measurement of the frequency pulling $f_{\mathrm{osc,pull}}$ 26
Figure 6 – Tuning linearity 29
Figure 7 – Circuit diagram for the measurement of the oscillation frequency temperature coefficient $\alpha_{\mathrm{f,temp}}$ 30
Figure 8 – Circuit diagram for the measurement of the modulation bandwidth B_{mod} 34
Figure 9 – Sensitivity flatness 36

Table 1 – Comparison of phase noise measuring methods 19

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.

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

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].

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted 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.

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
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*

---

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