



IEC 60747-16-5

Edition 1.1 2020-07
CONSOLIDATED VERSION

INTERNATIONAL STANDARD



**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.

REDLINE VERSION



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

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 ($P_{O,osc}$)	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 ($\mathcal{S}(f)$).....	19
5.4.1	Purpose.....	19
5.4.2	Measuring methods	19
5.5	Tuning sensitivity ($S_{f,v}$).....	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 ($f_{osc,push}$).....	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 ($f_{osc,pull}$).....	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 ($\Delta P_{O,osc}$).....	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 ($\alpha_{f,temp}$)	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 ($\alpha_{P,temp}$).....	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 $\mathcal{S}(f)$ (method 1)	20
	Figure 3 – Circuit diagram for the measurement of the phase noise $\mathcal{S}(f)$ (method 2)	22
	Figure 4 – Circuit diagram for the measurement of the phase noise $\mathcal{S}(f)$ (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] 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.

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 1:2009²⁾
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.~~

FINAL VERSION

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

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 ($P_{O,osc}$)	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 ($\mathcal{S}(f)$).....	19
5.4.1	Purpose.....	19
5.4.2	Measuring methods	19
5.5	Tuning sensitivity ($S_{f,v}$).....	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 ($f_{osc,push}$).....	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 ($f_{osc,pull}$).....	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 ($\Delta P_{O,osc}$).....	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 ($\alpha_{f,temp}$)	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 ($\alpha_{P,temp}$).....	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 $\mathcal{S}(f)$ (method 1)	20
	Figure 3 – Circuit diagram for the measurement of the phase noise $\mathcal{S}(f)$ (method 2)	21
	Figure 4 – Circuit diagram for the measurement of the phase noise $\mathcal{S}(f)$ (method 3)	22
	Figure 5 – Circuit diagram for the measurement of the frequency pulling $f_{osc,pull}$	26
	Figure 6 – Tuning linearity	29
	Figure 7 – Circuit diagram for the measurement of the oscillation frequency temperature coefficient $\alpha_{f,temp}$	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] and its corrigendum (2020-09).

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.