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Semiconductor devices –
Part 16-3: Microwave integrated circuits – Frequency converters
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Dispositifs à semiconducteurs –
Partie 16-3: Circuits intégrés hyperfréquences – Convertisseurs de fréquence
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SEMICONDUCTOR DEVICES –

**Part 16-3: Microwave integrated circuits –
Frequency converters**

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International Standard IEC 60747-16-3 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

This bilingual version, published in 2010-03, corresponds to the English version.

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

FDIS	Report on voting
47E/212/FDIS	47E/219/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.

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

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

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SEMICONDUCTOR DEVICES –

Part 16-3: Microwave integrated circuits – Frequency converters

1 Scope

This part of IEC 60747 provides new measuring methods, terminology and letter symbols, as well as essential ratings and characteristics for integrated circuit microwave frequency converters.

2 Normative references

The following referenced documents are indispensable for the application 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 60617-12, *Graphical symbols for diagrams – Part 12: Binary logic elements*

IEC 60617-13, *Graphical symbols for diagrams – Part 13: Analogue elements*

IEC 60747-1:1983, *Semiconductor devices – Discrete devices and integrated circuits – Part 1: General*

[IEC 60747-16-3:2002](#)

IEC 60748-2:1997, *Semiconductor devices – Integrated circuits – Part 2: Digital integrated circuits*

IEC 60748-3, *Semiconductor devices – Integrated circuits – Part 3: Analogue integrated circuits*

IEC 60748-4, *Semiconductor devices – Integrated circuits – Part 4: Interface integrated circuits*

3 Terms and definitions

For the purpose of this part of IEC 60747, the following terms and definitions apply:

3.1

conversion gain, G_c

ratio of the desired converted output power to the input power

NOTE Usually, the conversion gain is expressed in decibels.

3.2

conversion gain flatness, ΔG_c

difference between the maximum and the minimum conversion gain for a specified input power in a specified frequency range

3.3

LO/RF isolation, $P_{LO}/P_{LO(RF)}$

ratio of the incident local power to the local leakage power at the RF port with the IF port terminated in a specified impedance

3.4**LO/IF isolation, $P_{LO}/P_{LO(IF)}$**

ratio of the incident local power to the local leakage power at the IF port with the RF port terminated in a specified impedance

3.5**RF/IF isolation, $P_{RF}/P_{RF(IF)}$**

ratio of the incident RF power to the RF feedthrough power at the IF port for a specified local power

NOTE Usually, the RF/IF isolation is applied to the down-converter.

3.6**IF/RF isolation, $P_{IF}/P_{IF(RF)}$**

ratio of the incident IF power to the IF feedthrough power at the RF port for a specified local power

NOTE Usually, the IF/RF isolation is applied to the up-converter.

3.7**image rejection, $P_o/P_{o(im)}$**

ratio of the output power when the RF signal is applied, to the output power when the image signal is applied

NOTE Usually, the image rejection is applied to the down-converter.

3.8**sideband suppression, $P_o/P_{o(U)}$**

ratio of the output power of the desired sideband to the output power of the undesired sideband

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NOTE Usually, the sideband suppression is applied to the up-converter.

3.9**LO port return loss, $L_{ret(LO)}$**

ratio of the specified incident power at the LO port to the reflected power at the LO port, with the RF port and the IF port terminated in each specified impedance

3.10**RF port return loss, $L_{ret(RF)}$**

ratio of the incident power at the RF port to the reflected power at the RF port for a specified local power, with the IF port terminated in a specified impedance

3.11**IF port return loss, $L_{ret(IF)}$**

ratio of the incident power at the IF port to the reflected power at the IF port for a specified local power, with the RF port terminated in a specified impedance

3.12**output power, P_o**

see IEC 60747-16-2, 3.31

3.13**output power at 1-dB conversion compression, $P_{o(1dB)}$**

output power where the conversion gain decreases by 1 dB compared with the linear conversion gain

¹ IEC 60747-16-2:2001, *Semiconductor devices – Part 16-2: Microwave integrated circuits – Frequency prescalers*

3.14**noise figure, F**

see IEC 60747-1 Chapter IV, 5.4.4

3.15**intermodulation distortion, P_n/P_1**

ratio of the output power of the n th order component to the output power of the fundamental component, at a specified input power

3.16**output power at the intercept point (for intermodulation products), $P_{n(IP)}$**

output power at the intersection between the extrapolated output powers of the fundamental component and the n th order intermodulation components, when the extrapolation is carried out in a diagram showing the output power of the components (in decibels) as a function of the input power (in decibels)

4 Abbreviated terms

The abbreviations used in this part of IEC 60747 are as follows:

RF Radio Frequency;

IF Intermediate Frequency;

LO Local Oscillator.

5 Essential ratings and characteristics**5.1 General**

This clause gives ratings and characteristics required for specifying integrated circuit microwave frequency converters.

5.1.1 Circuit identification and types**5.1.1.1 Designation and types**

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

Microwave frequency converters are divided into two categories:

- type A: down-converter;
- type B: up-converter.

5.1.1.2 General function description

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

5.1.1.3 Manufacturing technology

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

5.1.1.4 Package identification

The following shall be stated:

- a) chip or packaged form;
- b) IEC and/or national reference number of the outline drawing, or of drawing of non-standard package including terminal numbering;
- c) principal package material, for example, metal, ceramic, plastic;
- d) for chip form: outlines, dimensions, pad sizes, contact material, and recommended contact technologies.

5.1.1.5 Main application

The main application shall be stated if necessary. If the device has restrictive applications, these too shall be stated here.

5.2 Application description

Information on the application of the integrated circuit and its relation to the associated devices shall be given.

5.2.1 Conformance to system and/or interface information

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

Detailed information about application systems, equipment and circuits such as VSAT systems, DBS receivers, microwave landing systems shall also be given.

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5.2.2 Overall block diagram

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

5.2.3 Reference data

The most important properties required to permit comparison between derivative types shall be given.

5.2.4 Electrical compatibility

It shall 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 shall be given concerning the type of the input and output circuits, for example, input/output impedances, d.c. block, open-drain.

Interchangeability with other devices, if any, shall be given.

5.2.5 Associated devices

If applicable, mention shall be made here of

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

5.3 Specification of the function

5.3.1 Detailed block diagram – functional blocks

A detail block diagram or equivalent circuit information of the integrated circuit microwave frequency converters 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) interdependence between the separate functional blocks.

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

For the purpose of providing additional information, the complete electrical circuit diagram can be reproduced, though this will not necessarily involve giving indications of the function. Rules governing such diagrams may be obtained from IEC 60617-12 or IEC 60617-13.

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5.3.2 Identification and function of terminals

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

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The terminal functions 1) to 4) shall be indicated as shown in table 1 below.

Table 1 – Function of terminals

Terminal number	Terminal symbol	1 Terminal designation	2 Function	3 Input/output identification	4 Type of input/output circuits

5.3.2.1 Function 1: Terminal designation

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

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

5.3.2.3 Function 3: Input/output identification

Input, output, input/output, and multiples of the input/output terminal shall be distinguished.

5.3.2.4 Function 4: Type of input/output circuits

The type of input and output circuits, for example, input/output impedances, with or without d.c. block, etc., shall be distinguished.

5.3.2.5 Function 5: Type of ground

If the baseplate of the package is used as ground, this shall be stated.

EXAMPLE:

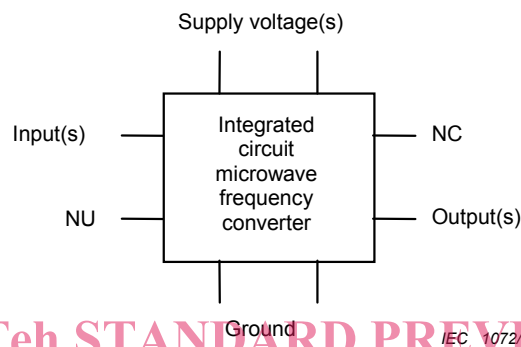


Figure 1 – Electrical terminal symbols

5.3.3 Function description

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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.);
- interruption handling.

5.3.4 Family related characteristics

All family-specific functional descriptions shall be stated (with reference to IEC 60748-2, IEC 60748-3 and IEC 60748-4).

If ratings, characteristics and function characteristics exist for the family, the relevant part of IEC 60748 shall be used (for example, for microprocessors, see IEC 60748-2, chapter III, section 3).

NOTE For each new device family, specific items shall be added to the relevant part of IEC 60748.

5.4 Limiting values (absolute maximum rating system)

The table giving these values shall specify the following:

- any interdependence of limiting conditions;
- 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 referenced to a specified reference terminal (V_{SS} , GND, 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;
- the ratings given shall cover the operation of the multi-function integrated circuit over the specified range of operating temperatures. Where such ratings are temperature-dependent, such dependence shall be indicated.

5.4.1 Electrical limiting values

Limiting values shall be specified as follows:

Table 2 – Electrical limiting values

Subclause	Parameters	Min.	Max.
5.4.1.1	Ambient or case temperature	+	+
5.4.1.2	Storage temperature	+	+
5.4.1.3	Power supply voltage(s)		+
5.4.1.4	Power supply current(s) (where appropriate)		+
5.4.1.5	Terminal voltage(s) (where appropriate)	+	+
5.4.1.6	Terminal current(s) (where appropriate)		+
5.4.1.7	Input power		+
5.4.1.8	LO input power		+
5.4.1.9	Power dissipation		+

The detail specification may indicate those values within table 2, including note 1 and note 2.

Parameters (see notes 1 and 2)	Symbols	Min.	Max.	Unit
<p>NOTE 1 Where appropriate, in accordance with the type of considered circuit.</p> <p>NOTE 2 For power supply voltage range:</p> <p>limiting value(s) of the continuous voltage(s) at the supply terminal(s) with respect to a special electrical reference point;</p> <p>where appropriate, limiting value between specified supply terminals;</p> <p>when more than one voltage supply is required, a statement should be made as to whether the sequence in which these supplies are applied is significant: if so, the sequence should be stated;</p> <p>when more than one supply is needed, it may be necessary to state the combinations of ratings for these supply voltages and currents.</p>				

5.4.2 Temperatures

- a) Operating temperature
- b) Storage temperature
- c) Channel temperature
- d) Lead temperature (for soldering)

The detail specification may indicate those values within the table including the note.

Parameters (see note)	Symbols	Min.	Max.	Unit
NOTE Where appropriate, in accordance with the type of considered circuit.				

5.5 Operating conditions (within the specified operating temperature range)

These are not to be inspected, but may be used for quality assessment purposes.

5.5.1 Power supplies – Positive and/or negative values

5.5.2 Initialization sequences (where appropriate)

If special initialization sequences are necessary, the power supply sequencing and initialization procedure shall be specified.

5.5.3 Input voltage(s) or input signal (where appropriate)

5.5.4 Output current(s) (where appropriate)

5.5.5 Voltage and/or current of other terminal(s)

5.5.6 External elements (where appropriate)

5.5.7 Operating temperature range

5.6 Electrical characteristics

The characteristics shall apply over the full operating temperature range, unless otherwise specified.

Each characteristic of 5.6 shall be stated: either

- a) over the specified range of operating temperatures, or
- b) at a temperature of 25 °C, and at maximum and minimum operating temperatures.

The parameters shall be specified corresponding to the type as shown in Table 3 below: