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Semiconductor devices –

Part 16-1: Microwave integrated circuits – Amplifiers

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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International Standard IEC 60747-16-1 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

This consolidated version of IEC 60747-16-1 consists of the first edition (2001) [documents 47E/200/FDIS and 47E/204/RVD] and its amendment 1 (2007) [documents 47E/305/FDIS and 47E/317/RVD].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result 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- withdrawn,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.

A bilingual version of this standard may be issued at a later date.

SEMICONDUCTOR DEVICES –

Part 16-1: Microwave integrated circuits – Amplifiers

1 Scope

This part of IEC 60747 provides the terminology, the essential ratings and characteristics, as well as the measuring methods for integrated circuit microwave power amplifiers.

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 60617:2001, *Graphical symbols for diagrams*

IEC 60747-1:2006, *Semiconductor devices – Part 1: General*

IEC 60747-4:-, *Semiconductor devices – Discrete devices – Part 4: Microwave diodes and transistors*[1]

IEC 60747-7:2000, *Semiconductor devices – Part 7: Bipolar transistors*

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

IEC 60747-16-4:2004, *Semiconductor devices – Part 16-4: Microwave integrated circuits – Switches*

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

IEC 60748-3:1986, *Semiconductor devices – Integrated circuits – Part 3: Analogue integrated circuits*

IEC 60748-4:1997, *Semiconductor devices – Integrated circuits – Part 4: Interface integrated circuits*

IEC/TS 61340-5-1:1998, *Electrostatics - Part 5-1: Protection of electronic devices from electrostatic phenomena - General requirements*

IEC/TS 61340-5-2:1999, *Electrostatics - Part 5-2: Protection of electronic devices from electrostatic phenomena - User guide*

3 Terminology

3.1
linear (power) gain G_{lin}
power gain in the linear region of the power transfer curve P_o (dBm) = $f(P_i)$

NOTE In this region, ΔP_o (dBm) = ΔP_i (dBm).

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1 The second edition of IEC 60747-4, which is cited in this standard, and to which terms introduced in this amendment refer, is currently in preparation (ADIS).

3.2
linear (power) gain flatness ΔG_{lin}
power gain flatness when the operating point lies in the linear region of the power transfer curve

3.3
power gain G_p, G
ratio of the output power to the input power

NOTE Usually the power gain is expressed in decibels.

3.4
(power) gain flatness ΔG_p
difference between the maximum and minimum power gain for a specified input power in a specified frequency range

3.5
(maximum available) gain reduction ΔG_{red}
difference in decibels between the maximum and minimum power gains that can be provided by the gain control

3.6 Output power limiting

3.6.1
output power limiting range
range in which, for rising input power, the output power is limiting

NOTE For specification purposes, the limits of this range are specified by specified lower and upper limit values for the input power.

3.6.2
limiting output power $P_{o(ltg)}$
output power in the range where it is limiting

3.6.3
limiting output power flatness $\Delta P_{o(ltg)}$
difference between the maximum and minimum output power in the output power limiting range:

$$\Delta P_{o(ltg)} = P_{o(ltg,max)} - P_{o(ltg,min)}$$

3.7
intermodulation distortion P_1/P_n
ratio of the fundamental component of the output power to the *n*th order component of the output power, at a specified input power

3.8
power at the intercept point (for intermodulation products) $P_{n(IP)}$
output power at 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)

3.9
magnitude of the input reflection coefficient
(input return loss)
$|S_{11}|$
see 3.5.2.1 of IEC 60747-7

3.10
magnitude of the output reflection coefficient
(output return loss)
$|S_{22}|$
see 3.5.2.2 of IEC 60747-7

3.11
magnitude of the reverse transmission coefficient
(isolation)
$|S_{12}|$
see 3.5.2.4 of IEC 60747-7

3.12
conversion coefficient of amplitude modulation to phase modulation $\alpha_{(AM\text{-}PM)}$
quotient of

the phase deviation of the output signal (in degrees) by

the change in input power (in decibels) producing it

3.13
group delay time $t_{d(grp)}$
ratio of the change, with angular frequency, of the phase shift through the amplifier

NOTE Usually group delay time is very close in value to input-to-output delay time.

3.14
***n*th order harmonic distortion ratio P_1/P_{nth}**
ratio of the power of the fundamental frequency measured at the output port of the device to the power of the *n*th order harmonic component measured at the output port for a specified output power

3.15
output noise power P_N
maximum noise power measured at the output port of the device within a specified bandwidth in a specified frequency range for a specified output power

3.16
spurious intensity under specified load VSWR P_o/P_{sp}
ratio of the power of the fundamental frequency measured at the output port of the device to the maximum spurious power measured at the output port under specified load VSWR

3.17
output power
P_o
see 3.3 of IEC 60747-16-2

3.18
output power at 1 dB gain compression
$P_{o(1dB)}$
see 8.2.13 of IEC 60747-4

3.19
noise figure
F
see 702-08-57 of IEC 60050-702

3.20
power added efficiency
η_{add}
see 8.2.15 of IEC 60747-4

3.21
adjacent channel power ratio
$P_{o(mod)}/P_{adj}$
see 3.10 of IEC 60747-16-4

3.22
load mismatch tolerance
Ψ_L
see 7.2.20 of IEC 60747-4

3.23
source mismatch tolerance
Ψ_S
see 7.2.21 of IEC 60747-4

3.24
load mismatch ruggedness
Ψ_R
see 7.2.22 of IEC 60747-4

4 Essential ratings and characteristics

4.1 General

4.1.1 Circuit identification and types

4.1.1.1 Designation and types

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

Microwave amplifiers are divided into four categories:

Type A: Low-noise type.

Type B: Auto-gain control type.

Type C: Limiting type.

Type D: Power type.

4.1.1.2 General function description

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

4.1.1.3 Manufacturing technology

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

4.1.1.4 Package identification

The following statements should be made:

a) IEC and/or national reference number of the outline drawing, or drawing of non-standard package including terminal numbering;

b) principal package material; for example, metal, ceramic, plastic.

4.1.1.5 Main application

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

4.2 Application related description

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

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 interface standard or recommendation.

The detailed information about application systems, equipment and circuits such as VSAT systems, DBS 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 to 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 of the type of the input and output circuits, for example, input/output impedances, d.c. block, open-drain, etc. Interchangeability with other devices, if any, should be given.

4.2.5 Associated devices

If applicable, the following should be stated here:

– 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 amplifiers should be given. The block diagram should be composed of the following:

1) functional blocks;

2) mutual interconnections among the functional blocks;

3) individual functional units within the functional blocks;

4) mutual interconnections among the individual functional blocks;

5) function of each external connection;

6) interdependence between the separate functional blocks.

The block diagram should identify the function of each external connection and, where no ambiguity can arise, can also show the terminal symbols and/or numbers. If the encapsulation has metallic parts, any connection to them from external terminals should be indicated. The connections with any associated external electrical elements should 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. This may be obtained from a catalogue of standards of graphical symbols or designed according to the rules of IEC 60617.

4.3.2 Identification and function of terminals

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

The terminal functions 1)-4) should be indicated in a table as follows:

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

1) Terminal name

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

2) Function

A brief indication of the terminal function should be given.

– Each function of multi-role terminals, that is terminals that have multiple functions.

– Each function of the 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) Input/output identification

Input, output, input/output, and multiplex input/output terminals should be distinguished.

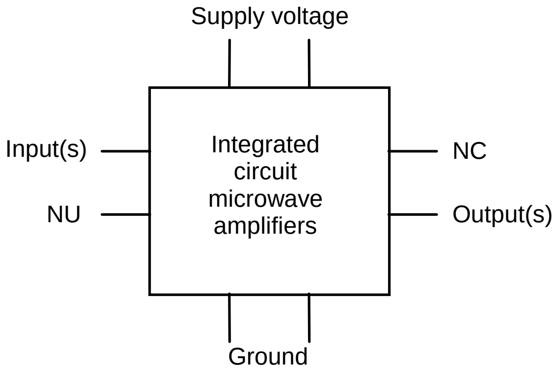
4) Type of input/output circuits

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

5) Type of ground

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

Example:



4.3.3 Functional description

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

- basic function;
- relation to external terminals;
- operation mode (for example, set-up method, preference, etc.);
- interrupt handling.

4.3.4 Family-related characteristics

In this part, all the family-specific functional descriptions shall be stated (refer to IEC 60748-2, IEC 60748-3 and IEC 60748-4).

If ratings and characteristics and function characteristics exist for the family, the relevant part of IEC 60748 should 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 in the relevant part of IEC 60748.

4.4 Limiting values (absolute maximum rating system)

The table of these values contains the following.

a) Any interdependence of limiting conditions shall be specified.

b) 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.

c) If limiting values are exceeded for transient overload, the permissible excess and their duration shall be specified.

d) Where minimum and maximum values differ during programming of the device, this should be stated.

e) All voltages are referenced to a specified reference terminal (V_{SS}, G_{ND}, etc.).

f) In satisfying the following clauses, if maximum and/or minimum values are quoted, the manufacturer must indicate whether he refers to the absolute magnitude or to the algebraic value of the quantity.

g) The ratings given must cover the operation of the multi-function integrated circuit over the specified range of operating temperatures. Where such ratings are temperature-dependent, this dependence should be indicated.