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Edition 1.0 2001-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Semiconductor devices –
Part 16-1: Microwave integrated circuits – Amplifiers

Dispositifs à semiconducteurs –
Partie 16-1: Circuits intégrés hyperfréquences – Amplificateurs

IEC 60747-16-1:2001

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FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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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 bilingual version (2012-09) corresponds to the monolingual English version, published in 2001-11.

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

FDIS	Report on voting
47E/200/FDIS	47E/204/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 2004. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

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 normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60747. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60747 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60617-12:1997, *Graphical symbols for diagrams – Part 12: Binary logic elements*

IEC 60617-13:1993, *Graphical symbols for diagrams – Part 13: Analogue elements*

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

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

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*

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).

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_n/P_i
ratio of

the output power of the nth order component to

the output power of the fundamental component,

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 nth 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
nth order harmonic distortion ratio P_{nth}/P_1
ratio of the power of the nth order harmonic component measured at the output port of the device to the power of the fundamental frequency 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_{sp}/P_o
ratio of the maximum spurious power measured at the output port of the device to the power of the fundamental frequency measured at the output port under specified load VSWR

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 60617-12 or IEC 60617-13.

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.

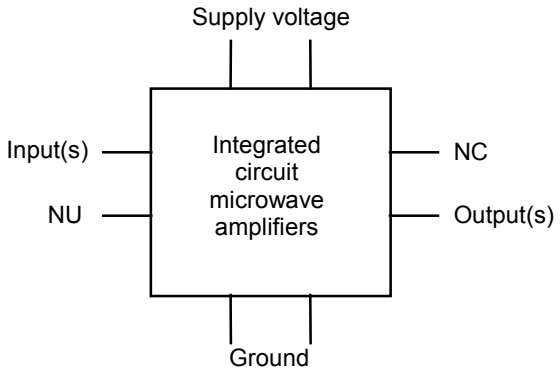
4) Type of input/output circuits

   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.

4.4.1 Electrical limiting values

Limiting values should be specified as follows.

Parameters		Min.	Max.
(1)	Power supply voltages	+	+
(2)	Power supply currents (where appropriate)		+
(3)	Input voltage(s) (where appropriate)	+	+
(4)	Output voltage(s) (where appropriate)	+	+
(5)	Input current(s) (where appropriate)		+
(6)	Output current(s) (where appropriate)		+
(7)	Other terminal voltage(s) (where appropriate)	+	+
(8)	Other terminal current(s) (where appropriate)		+
(9)	Voltage difference between input and output (where appropriate)	+	+
(10)	Power dissipation		+

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

Parameters (Note 1, Note 2)	Symbols	Min.	Max.	Unit

NOTE 1 Where appropriate, in accordance with the type of circuit considered.

NOTE 2 For power supply voltage range:

– limiting value(s) of the continuous voltage(s) at the supply terminal(s) with respect to a special electrical reference point;

– where appropriate, limiting value between specified supply terminals;

– 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;

– when more than one supply is needed, it may be necessary to state the combinations of ratings for these supply voltages and currents.

4.4.2 Temperatures

1) Operating temperature
2) Storage temperature
3) Channel temperature (type C and type D only)
4) Lead temperature (for soldering).

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

Parameters (Note)	Symbols	Min.	Max.	Unit

NOTE Where appropriate, in accordance with the type of circuit considered.

4.5 Operating conditions (within the specified operating temperature range)

They are not to be inspected but may be used for quality assessment purpose.

4.5.1 Power supplies positive and/or negative values

4.5.2 Initialization sequences (where appropriate)

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

4.5.3 Input voltage(s) (where appropriate)

4.5.4 Output current(s) (where appropriate)

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

4.5.6 External elements (where appropriate)

4.5.7 Operating temperature range

4.6 Electrical characteristics

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

Each characteristic of 4.6.1 and 4.6.2 should 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.

4.6.1 Static characteristics

The parameters should be specified corresponding to the type as follows.

Parameters	Min.	Typ.[a]	Max.	Types			
				A	B	C	D
4.6.1.1 Power supply current	+	+	+	+	+	+	+
4.6.1.2 Thermal resistance			+			+	+
[a] Optional							

The detail specification may indicate those values within the table.

Characteristics	Symbols	Conditions	Min.	Typ.[a]	Max.	Unit
[a] Optional						

4.6.2 Dynamic or a.c. characteristics

Each dynamic or a.c. electrical characteristic should be stated under specified electrical worst-case conditions with respect to the recommended range of supply voltages, as stated in 4.5.1.