IEC 60747-16-4

Edition 1.1 2011-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Semiconductor devices – Part 16-4: Microwave integrated circuits – Switches

Dispositifs à semiconducteurs – Partie 16-4: Circuits intégrés hyperfréquences – Commutateurs

IEC 60747-16-4:2004+A1:2009

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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This consolidated version of IEC 60747-16-4 consists of the first edition (2004) [documents 47E/256/FDIS and 47E/261/RVD] and its amendment 1 (2009) [documents 47E/358/CDV and 47E/373/RVC]. It bears the edition number 1.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

International Standard IEC 60747-16-4 has been prepared by subcommittee 47E: Discrete semiconductor devices, of IEC technical committee 47: Semiconductor devices.

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

This bilingual consolidated version (2011-11) replaces the English version.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of the base publication and its amendments 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- withdrawn,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 publication using a colour printer.

SEMICONDUCTOR DEVICES –

Part 16-4: Microwave integrated circuits – Switches

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 switches.

There are many combinations for RF ports in switches, such as SPST (single pole single throw), SPDT (single pole double throw), SP3T (single pole triple throw), DPDT (double pole double throw), etc. Switches in this standard are based on SPDT. However, this standard is applicable to the other types of switches.

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 60617, *Graphical symbols for diagrams*

~~IEC 60747-1(1983), *Semiconductor devices – Discrete devices and integrated circuits – Part 1: General*~~
~~Amendment 3 (1996)~~

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

IEC 60747-4, *Semiconductor devices – Discrete devices – Part 4: Microwave devices*

IEC 60747-16-1:2001, *Semiconductor devices – Part 16-1: Microwave integrated circuits – Amplifiers*
Amendment 1 (2007)[1]

IEC 60748-2, *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*

IEC 61340-5-1:2007, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*

IEC/TR 61340-5-2:2007, *Electrostatics – Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide*

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[1] There exists a consolidated edition 1.1 published in 2007, including the base publication (2001) and its Amendment 1 (2007).

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

Terms related to electrical characteristics

3.1
insertion loss
L_{ins}
ratio of the ~~out~~ input power to the output power at the switched on port, ~~to the input power~~ in the linear region of the power transfer curve P_o (dBm) = $f(P_i)$

NOTE 1 In this region, ΔP_o (dBm) = ΔP_i (dBm).

NOTE 2 Usually the insertion loss is expressed in decibels.

3.2
isolation
L_{iso}
ratio of the ~~out~~ input power to the output power at the switched off port, ~~to the input power~~ in the linear region of the power transfer curve P_o (dBm) = $f(P_i)$

NOTE 1 In this region, ΔP_o (dBm) = ΔP_i (dBm).

NOTE 2 Usually the isolation is expressed in decibels.

3.3
return loss
L_{ret}
ratio of the incident power P_{inc} at the specified port to the reflected power P_{ref} at the same port in the linear region of the power transfer curve P_{ref} (dBm) = $f(P_{inc})$

NOTE 1 In this region, ΔP_{ref} (dBm) = ΔP_{inc} (dBm).

NOTE 2 Usually the return loss is expressed in decibels.

3.4
input power at 1 dB compression
$P_{i(1\ dB)}$
input power where the insertion loss increases by 1 dB compared with insertion loss in linear region

3.5
output power at 1 dB compression
$P_{o(1dB)}$
output power where the insertion loss increases by 1 dB compared with insertion loss in linear region

3.6
turn on time
t_{on}
interval between the lower reference point on the leading edge of the control voltage and the upper reference point on the leading edge of the envelope of the output voltage 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).

3.7
turn off time
t_{off}
interval between the upper reference point on the trailing edge of the control voltage and the lower reference point on the trailing edge of the envelope of the output voltage 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).

3.8
rise time
$t_{r(out)}$
interval between the lower reference point on the leading edge of the output voltage and the upper reference point on the leading edge of the envelope of the output voltage 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).

3.9
fall time
$t_{f(out)}$
interval between the upper reference point on the trailing edge of the output voltage and the lower reference point on the trailing edge of the envelope of the output voltage 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).

3.10
adjacent channel power ratio
$P_{o(mod)}/P_{adj}$
ratio of the total power in the specified carrier signal frequency band to total output power in the specified frequency band away from the specified carrier signal frequency, at the specified output power when the modulation signal is supplied

3.11
~~**n-th order harmonic distortion ratio**~~
~~P_{nth}/P_1~~
~~See 3.14 of IEC 60747-16-1(2001).~~

***n*th order harmonic distortion ratio**
P_1/P_{nth}
See 3.14 of Amendment 1 of IEC 60747-16-1:2007.

4 Essential ratings and characteristics

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

4.1 Circuit identification and types

4.1.1 Designation and types

Identification of type (device name), category of circuit and technology applied should be given. Microwave switches comprise one category.

4.1.2 General function description

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

4.1.3 Manufacturing technology

The manufacturing technology, e.g. semiconductor monolithic integrated circuit, thin film integrated circuit, micro-assembly, etc. should be stated. This statement should include details of the semiconductor technologies such as Schottky-barrier diode, PIN diode, MESFET, Si bipolar transistor, etc.

IEC 60747-4 should be referred to for terminology and letter symbols, essential ratings and characteristics and measuring methods of such microwave devices.

4.1.4 Package identification

The following statements should be made:

a) chip or packaged form;

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

c) principal package material, for example, metal, ceramic, plastic.

4.1.5 Main application

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

4.2 Application description

Information on 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 an interface standard or a recommendation.

Detailed information concerning 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 that 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 concerning the type of input and output circuits, e.g. input/output impedances, d.c. block, open-drain, etc. Interchangeability with other devices, if any, should also be given.

4.2.5 Associated devices

If applicable, the following should be stated:

– 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 switches should be given. The block diagram should 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) inter-dependence between the separate functional blocks.

The block diagram should identify the function of each external connection and, where no ambiguity can arise, 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. Rules governing such diagrams may be obtained from 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) to 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 circuits

1) Terminal designation

A terminal designation to indicate the function of the 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, i.e. terminals having multiple functions;

– each function of 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.

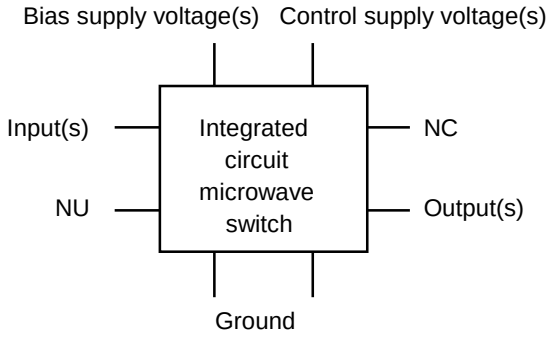
4) Type of input/output circuits

The type of input and output circuit, e.g. 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 Function description

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

– basic function;

– relation to external terminals;

– operation mode (e.g., 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 (referred to IEC 60748-2, IEC 60748-3 and IEC 60748-4).

If ratings and characteristics, as well as function characteristics exist for the family, the relevant part of IEC 60748 should be used (e.g. for microprocessors, see IEC 60748-2, Chapter III, Section Three).

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

4.4 Limiting values (absolute maximum rating system)

The table for these values should contain the following:

– Any interdependence of limiting conditions shall be specified.

– 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 should be stated.

– All voltages are referenced to a specified reference terminal (V_{SS}, ground, 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, these dependence should be indicated.

4.4.1 Electrical limiting values

Limiting values should be specified as follows:

Subclause	Parameters	Min.	Max.
4.4.1.1	Bias supply voltage(s) (where appropriate)		+
4.4.1.2	Bias supply current(s) (where appropriate)		+
4.4.1.3	Control supply voltage(s) (where appropriate)		+
4.4.1.4	Control supply current(s) (where appropriate)		+
4.4.1.5	Terminal voltage(s) (where appropriate)	+	+
4.4.1.6	Terminal current(s) (where appropriate)		+
4.4.1.7	Input power		+
4.4.1.8	Power dissipation		+
NOTE It is necessary to select either 4.4.1.1 or 4.4.1.2, either 4.4.1.3 or 4.4.1.4, and either 4.4.1.5 or 4.4.1.6.			

The detail specification may indicate those values within the table including notes 1 and 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

a) Operating temperature (ambient or reference-point temperature)

~~b) Ambient or case temperature~~

~~c~~ b) Storage temperature

~~d~~ c) Channel temperature

~~e~~ d) 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 purposes.

4.5.1 Power supplies – Positive and/or negative values

4.5.2 Initialization sequences (where appropriate)

If special initialization sequences are necessary, power supply sequencing and 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.

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

Subclause	Parameters	Min.	Typical[a]	Max.
4.6.1	Bias supply operating current		+	+
4.6.2	Control supply operating current		+	+
4.6.3	Insertion loss		+	+
4.6.4	Isolation (where appropriate)	+	+	
4.6.5	Return loss		+	+
4.6.6[b]	Input power at 1 dB compression point (where appropriate)	+	+	
4.6.7	Output power at 1 dB compression point (where appropriate)	+	+	
4.6.8	Turn-on time		+	+
4.6.9	Turn-off time		+	+
4.6.10	Rise time (where appropriate)		+	+
4.6.11	Fall time (where appropriate)		+	+
4.6.12	Adjacent channel power ratio (where appropriate)	+	+	~~+~~
4.6.13	*n*th order harmonic distortion ratio (where appropriate)	+	+	~~+~~

[a] Optional.

[b] It is necessary to select either 4.6.6 or 4.6.7.

The detail specification may indicate those values within the table.

Characteristics	Symbols	Conditions	Min.	Typical[a]	Max.	Units

[a] Optional.

4.7 Mechanical and environmental ratings, characteristics and data

Any specific mechanical and environmental ratings applicable should be stated (see also 5.10 and 5.11 of IEC 60747-1~~, Chapter VI, Clause 7~~).