INTERNATIONAL STANDARD

IEC 60191-6-4

First edition 2003-06

Mechanical standardization of semiconductor devices –

Part 6-4: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Measuring methods for package dimensions of ball grid array (BGA)

Normalisation mécanique des dispositifs à semiconducteurs –

Partie 6-4: Règles générales pour la préparation des dessins d'encombrement des dispositifs à semiconducteurs à montage en surface – Méthodes de mesure pour les dimensions des boîtiers matriciels à billes



Reference number IEC 60191-6-4:2003(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

IEC Web Site (<u>www.iec.ch</u>)

Catalogue of IEC publications

The on-line catalogue on the IEC web site (<u>http://www.iec.ch/searchpub/cur_fut.htm</u>) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

IEC Just Published

This summary of recently issued publications (<u>http://www.iec.ch/online_news/justpub/jp_entry.htm</u>) is also available by email. Please contact the Customer Service Centre (see below) for further information.

Customer Service Centre

If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

Email: <u>custserv@iec.ch</u> Tel: +41 22 919 02 11 Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

IEC 60191-6-4

First edition 2003-06

Mechanical standardization of semiconductor devices –

Part 6-4: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Measuring methods for package dimensions of ball grid array (BGA)

Normalisation mécanique des dispositifs à semiconducteurs –

Partie 6-4: Règles générales pour la préparation des dessins d'encombrement des dispositifs à semiconducteurs à montage en surface – Méthodes de mesure pour les dimensions des boîtiers matriciels à billes

© IEC 2003 — Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale International Electrotechnical Commission Международная Электротехническая Комиссия



Ρ

For price, see current catalogue

CONTENTS

– 2 –

FOI	FOREWORD							
1	Scop	e	4					
2	Norm	ative references	4					
3	Term	s and definitions	4					
4	Refer	eference character and drawings5						
	4.1	Ball grid array package (BGA) Type 1 – Ball datum	5					
	4.2	Ball grid array package (BGA) Type 2 – Body datum	6					
Measuring method								
	5.1	Datum S as pertaining to ball coplanarity	7					
	5.2	Datum A, B	7					
	5.3 5.4	Profile of a package edge surface v	9					
	5.4	Mounting height A	12					
	5.6	First stand-off A1	12					
	5.7	Second stand-off A41	13					
	5.8	Ball diameter b1	14					
	5.9	Ball centre position X1	14					
	5.10	Ball coplanarity y1	6					
	5.11	Package top flatness y11	6					
Fig	ure 1 -	- BGA package Type 1 – Ball datum	5					
Fig	ure 2 -	- BGA package Type 2 – Body datum	6					
Fig	ure 3 -	- Datum S	7					
Fig	ure 4 -	- Datum A, B – Type 1	8					
Fig	ure 5 -	- Centre of ball centres (for an even number)	8					
Fig	ure 6 -	- Centre of ball centres (for an odd number)	8					
Fig	ure 7 -	- Datum A – Type 2	9					
Fig	ure 8 -	– Datum B – Type 2	9					
Fig	ure 9 -	- Tolerance w1	0					
Fig	ure 10	– Measuring method of tolerance w1	10					
Fig	ure 11	- Profile of a package edge surface v1	1					
Fig	ure 12	– Measuring method of package edge surface v1	1					
Fig	ure 13	– Mounting height A1	12					
Fig	ure 14	– First stand-off A11	12					
Fig	ure 15	– Measuring method of stand-off A11	13					
Fig	ure 16	– Second stand-off A41	13					
Fig	ure 17	– Measuring method of stand-off A41	4					
Fig	ure 18	– Ball diameter b1	4					
Fig	ure 19	– Ball centre position X	15					
Fig	ure 20	– Theoretically correct ball centre1	15					
Fig	ure 21	– Measuring method of ball centre position X1	5					
Fig	ure 22	– Ball coplanarity y1	16					
Fig	ure 23	– Package top flatness y11	16					

INTERNATIONAL ELECTROTECHNICAL COMMISSION

MECHANICAL STANDARDIZATION OF SEMICONDUCTOR DEVICES –

Part 6-4: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Measuring methods for package dimensions of ball grid array (BGA)

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.
- 2) The formal decisions or agreements of the 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 National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
- 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60191-6-4 has been prepared by subcommittee 47D: Mechanical standardization of semiconductor devices, of IEC technical committee 47: Semiconductor devices.

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

FDIS	Report on voting
47D/531/FDIS	47D/546/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.

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

The committee has decided that the contents of this publication will remain unchanged until 2006. At this date, the publication will be

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

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

MECHANICAL STANDARDIZATION OF SEMICONDUCTOR DEVICES –

Part 6-4: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Measuring methods for package dimensions of ball grid array (BGA)

1 Scope

This part of IEC 60191 covers the requirements for the measuring methods of ball grid array (BGA) dimensions.

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 60191-6:1990, Mechanical standardization of semiconductor devices – Part 6: General rules for the preparation of outline drawings of surface mounted semiconductor device packages

3 Terms and definitions

For the purposes of this document, the definitions of IEC 60191-6 apply.

The measuring method in this standard is defined for dimension values guaranteed to users on the basis of the following items.

- 1) In general, measurement may be made either by hand or automatically.
- 2) If a dimension is difficult to measure, the best alternative measuring method will be defined as the preferred measuring method.

4 Reference character and drawings

4.1 Ball grid array package (BGA) Type 1 – Ball datum



Figure 1 – BGA package Type 1 – Ball datum



- 6 -

4.2 Ball grid array package (BGA) Type 2 – Body datum

Figure 2 – BGA package Type 2 – Body datum

5 Measuring method

5.1 Datum S as pertaining to ball coplanarity

The datum S (seating plane) can be determined by either of the following:

a) Datum S formed from the triangulation of the tallest three balls.

The tallest three balls defining the seating plane must fully encompass the projection of the centre of gravity (COG) in order to constitute a valid seating plane.

b) Datum S calculated from the LSM (least squares method) plane applies to stand-off A2, stand-off A1, the ball centre point and coplanarity. Calculate a plane from each lowest point of all balls based on LSM. Datum S shall be the LSM plane shifted to bottom of the lowest ball.



Figure 3 – Datum S

5.2 Datum A, B

a) Type 1

Centres of opposite sides of a package, which are defined below, shall be connected together.

An angle subtended by the two crossing lines shall be obtained. A difference $|90^{\circ} - \beta|$ of the angle from 90° shall be equally distributed to the sides to obtain orthogonal axes. These datum A and B should be the perpendicular planes to the datum S.



- 8 -

Definition of the centre of sides

IEC 1427/03





(for an even number)

Figure 6 – Centre of ball centres (for an odd number)

b) Type 2

On the E sides of the package (see Figure 2), a minimum of 4 points shall be selected (points 1-4) (see Figure 7). The lines shall be drawn from these points (1-2 and 3-4).

The lines that pass through the midpoints of these two lines (5 and 6) will hereafter be referred to as datum A.

On the D sides of the package (see Figure 2) coinciding with datum A, 2 points shall be selected (7 and 8) (see Figure 8). The line perpendicular to datum A passing through the midpoint of this line (7-8) will hereafter be referred to as datum B.



- 9 -

Figure 7 – Datum A – Type 2



Figure 8 – Datum B – Type 2

5.3 Definition of specified dimensions and measuring method

a) Tolerance w of the centre position of package length and width

The package width and length should be defined as a distance between parallel tangent lines which touched package profile. The centre of the package should be defined as the centre of these parallels. Tolerance w of the centre position of package length and width should be defined as a tolerance of it.



- 10 -

Figure 9 – Tolerance w

b) Measuring method

Put the package on the surface plate.

- 1) The package width and length should be defined as a distance between parallel tangent lined which touches package profile.
- 2) Make sure the centre of it is within the range w centring on datum A and B.



IEC 1433/03

Figure 10 – Measuring method of tolerance w

5.4 Profile of a package edge surface v

Profile of a package edge surface v should be defined as the range centring on the position which is a theoretically correct distance of D or E.



Figure 11 – Profile of a package edge surface v

Measuring method

The package size in both directions shall be determined by the length and width of the maximum and minimum square (or rectangle) to the package perimeter. Place the package on the seating plane and align pin one of the package to the gauge block to assure the package edges fall within the package tolerances (see Figure 12).



NOTE Excluding parts of chamfer.

Figure 12 – Measuring method of package edge surface \boldsymbol{v}

5.5 Mounting height A

Let the height of a package from the seating plane to the top of the package be defined as the mounting height. The mounting height therefore includes inclination and warping of the package.

- 12 -



Figure 13 – Mounting height A

Measuring method

- 1) Put the package on the surface plate.
- 2) From the top or side, measure the distance to the highest point. Let the distance be denoted as the mounting height.

5.6 First stand-off A1

First stand-off is defined as the distance from the seating plane to the lowest point of the package except the cavity.



Figure 14 – First stand-off A1

Measuring method

First stand-off is the distance measured from the calculate datum S based on the LSM (least squares method) to the lowest point on the package except the cavity.



Figure 15 – Measuring method of stand-off A1

5.7 Second stand-off A4

Second stand-off is defined as the distance from the seating plane to the lowest point of the cavity.



Figure 16 – Second stand-off A4

Measuring method

Second stand-off is the distance measured from the calculate datum S based on LSM (least squares method) to the lowest point on the cavity.



Figure 17 – Measuring method of stand-off A4

5.8 Ball diameter b

Ball diameter is defined as the diameter of a circle circumscribed about a vertical projection of the ball from the seating plane.



Figure 18 – Ball diameter b

Measuring method

- 1) Make the calculate datum S based on LSM (least squares method) coincide with the measuring reference.
- 2) Measure the diameter of a circle circumscribed about the ball.

5.9 Ball centre position X

Based on datum A, B and S, determine the difference between the theoretically correct position of each ball's centre and the actual position. That allowable distance to be the ball centre position tolerance (X/2).



Figure 19 – Ball centre position X

Figure 20 – Theoretically correct ball centre

Measuring method

- 1) Calculate datum S based on the LSM (least squares method) and datum A, B coincides and parallel with the measuring reference.
- 2) Determine centre of each ball.
- 3) Determine distance to the theoretically correct ball centre.
- 4) Check if distance lines within the ball positional tolerance.



Figure 21 – Measuring method of ball centre position X

5.10 Ball coplanarity y

Coplanarity y is defined as the distance from the lowest point of the top ball from the seating plane measured in the direction perpendicular to the seating plane.



Figure 22 – Ball coplanarity y

Measuring method

- Measure the distance y from datum S to highest ball. The distance can be determined by defining the datum S by either using the triangulation of the three tallest balls or the LSM (least squares method).
- 2) Ball coplanarity y to be the maximum value.

5.11 Package top flatness y1

Package top flatness is defined as the difference between the distances from seating plane to the highest points of the package top and distance to the lowest points.



Figure 23 – Package top flatness y1

Measuring method

- 1) Put the package on the surface plate.
- 2) From the side or top, measure the distance to the highest and lowest points of the package top. Package top flatness to be the difference between those values.



The IEC would like to offer you the best quality standards possible. To make sure that we continue to meet your needs, your feedback is essential. Would you please take a minute to answer the questions overleaf and fax them to us at +41 22 919 03 00 or mail them to the address below. Thank you!

Customer Service Centre (CSC)

International Electrotechnical Commission 3, rue de Varembé 1211 Genève 20 Switzerland

or

Fax to: IEC/CSC at +41 22 919 03 00

Thank you for your contribution to the standards-making process.



Nicht frankieren Ne pas affranchir



Non affrancare No stamp required

RÉPONSE PAYÉE SUISSE

Customer Service Centre (CSC) International Electrotechnical Commission 3, rue de Varembé 1211 GENEVA 20 Switzerland

Q1	Please report on ONE STANDARD and ONE STANDARD ONLY . Enter the exact number of the standard: (e.g. 60601-1-1)			If you ticked NOT AT ALL in Question 5 the reason is: <i>(tick all that apply)</i>	
)		standard is out of date	
				standard is incomplete	
				standard is too academic	
Q2	Please tell us in what capacity(ies) you			standard is too superficial	
	bought the standard (tick all that apply).			title is misleading	
				I made the wrong choice	
	purchasing agent			other	
	librarian				
	researcher				
	design engineer		07	Please assess the standard in the	
	safety engineer		u ,	following categories, using	
	testing engineer			the numbers:	
	marketing specialist			(1) unacceptable,	
	other			(2) below average, (3) average	
				(4) above average.	
03	Lwork for/in/ac a:			(5) exceptional,	
Q.)	I WORK TOF/IN/AS A: (tick all that apply)			(6) not applicable	
				timolinoco	
	manufacturing			quality of writing	
	consultant			technical contents	
	government			logic of arrangement of contents	
	test/certification facility			tables, charts, graphs, figures	
	public utility			other	
	education				
	military				
	other		Q8	I read/use the: (tick one)	
04	This standard will be used for:			French text only	
44	(tick all that apply)			English text only	
				both English and French texts	
	general reference				_
	product research				
	product design/development				
	specifications		Q9	Please share any comment on any	
	tenders			aspect of the IEC that you would like	
	quality assessment			us to know.	
	certification				
	technical documentation				
	thesis				
	manufacturing				
	other				
Q5	This standard meets my needs:				•••••
	(tick one)				
	not at all				
	fairly well				
	exactly				

LICENSED TO MECON Limited. - RANCHI/BANGALORE FOR INTERNAL USE AT THIS LOCATION ONLY, SUPPLIED BY BOOK SUPPLY BUREAU.



ICS 31.080.01