

# INTERNATIONAL STANDARD

**IEC**  
**60191-6-5**

First edition  
2001-08

---

---

## **Mechanical standardization of semiconductor devices –**

### **Part 6-5:**

### **General rules for the preparation of outline drawings of surface mounted semiconductor device packages –**

### **Design guide for fine-pitch ball grid array (FBGA)**

*Normalisation mécanique des dispositifs à semiconducteurs*

*Partie 6-5:*

*Règles générales pour la préparation des dessins  
d'encombrement des dispositifs à semiconducteurs  
à montage en surface –*

*Guide de conception pour les boîtiers matriciels à billes  
et à pas fins (FBGA)*



Reference number  
IEC 60191-6-5:2001(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** ([www.iec.ch](http://www.iec.ch))

- **Catalogue of IEC publications**

The on-line catalogue on the IEC web site ([www.iec.ch/catlg-e.htm](http://www.iec.ch/catlg-e.htm)) 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 On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.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 ([www.iec.ch/JP.htm](http://www.iec.ch/JP.htm)) 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: [custserv@iec.ch](mailto:custserv@iec.ch)  
Tel: +41 22 919 02 11  
Fax: +41 22 919 03 00

# INTERNATIONAL STANDARD

# IEC 60191-6-5

First edition  
2001-08

---

---

## Mechanical standardization of semiconductor devices –

### Part 6-5:

### General rules for the preparation of outline drawings of surface mounted semiconductor device packages –

### Design guide for fine-pitch ball grid array (FBGA)

*Normalisation mécanique des dispositifs à semiconducteurs*

*Partie 6-5:*

*Règles générales pour la préparation des dessins  
d'encombrement des dispositifs à semiconducteurs  
à montage en surface –*

*Guide de conception pour les boîtiers matriciels à billes  
et à pas fins (FBGA)*

© IEC 2001 — 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  
Telefax: +41 22 919 0300

3, rue de Varembe Geneva, Switzerland  
e-mail: [inmail@iec.ch](mailto:inmail@iec.ch)

IEC web site <http://www.iec.ch>



Commission Electrotechnique Internationale  
International Electrotechnical Commission  
Международная Электротехническая Комиссия

PRICE CODE

**K**

*For price, see current catalogue*

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MECHANICAL STANDARDIZATION OF SEMICONDUCTOR DEVICES –**

**Part 6-5: General rules for the preparation of outline drawings  
of surface mounted semiconductor device packages –  
Design guide for fine-pitch ball grid array (FBGA)**

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 60191-6-5 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/437/FDIS	47D/455/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 3.

The committee has decided that the contents of this publication will remain unchanged until 2003. 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.

[IECNORM.COM](http://IECNORM.COM) : Click to view the full PDF of IEC 60191-6-5:2001

## MECHANICAL STANDARDIZATION OF SEMICONDUCTOR DEVICES –

### Part 6-5: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Design guide for fine-pitch ball grid array (FBGA)

#### 1 Scope

This part of IEC 60191 provides common outline drawings and dimensions for all types of structures and composed materials of fine-pitch ball grid array (hereinafter called FBGA), whose terminal pitch is less than, or equal to, 0,80 mm and whose package body outline is square.

The demand for area array style packages exists according to the multi-functioning and high performance of electrical equipment. The object of this design guide is to standardize outlines and secure interchangeability of FBGA packages. The terminal pitch and package outlines of these fine-pitch array packages are smaller than those of BGA packages.

#### 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60191. 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 60191 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 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 Definitions

For the purposes of this part of IEC 60191, the definitions contained in IEC 60191-6 as well as the following definitions apply.

##### 3.1

##### **flanged type**

type whose package body size (body length and width) consists of its own flange which is composed around the encapsulation or lid

##### 3.2

##### **type of real chip size**

type whose package body size (body length and width) consists of an encapsulation just around the real chip only

**3.3****fine-pitch ball grid array (FBGA)**

packages with metal balls whose terminal pitch is less than, or equal to, 0,80 mm positioned in an array on the base plane of the package as external terminals. This package structure makes it possible to surface-mount the packages to the printed circuit board

**3.4****material designation**

FBGA packages are classified according to the following two material designations:

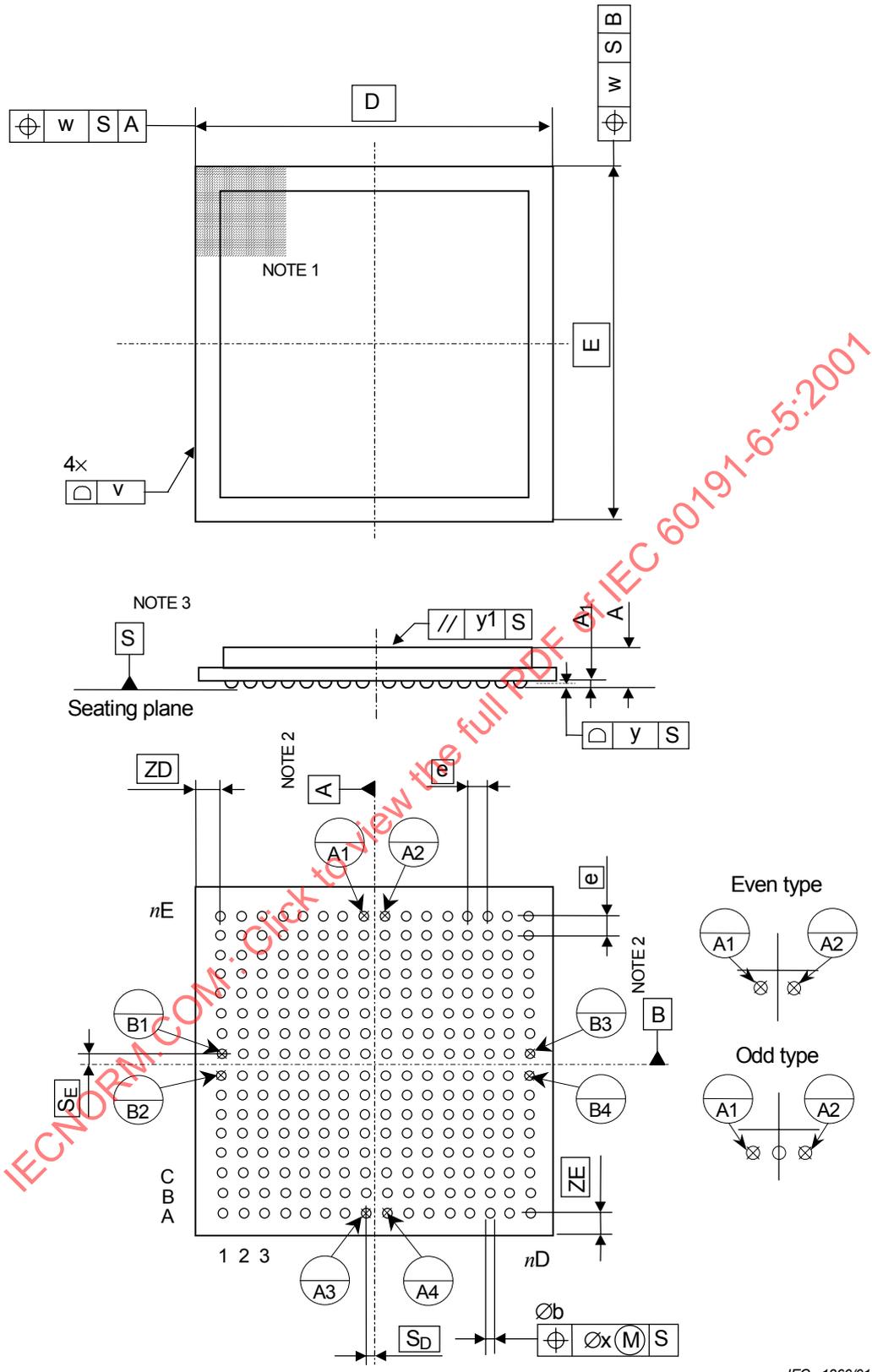
**3.4.1****plastic type (P-FBGA)**

plastic-type classification is assigned to packages which consist of resin substrate as interposer material (e.g. glass-epoxy, polyimid)

**3.4.2****ceramic type (C-FBGA)**

ceramic-type classification is assigned to packages which consist of ceramic substrate as interposer material

IECNORM.COM : Click to view the full PDF of IEC 60191-6-5:2001



IEC 1360/01

NOTE 1 Zone of a visible index on the top surface.

NOTE 2 Datum A and B are the axes defined by the terminal positions indicated with datum targets.

NOTE 3 Primary datum S and seating plane to be defined by the method of least squares of spherical crowns of land.

Table 1 – Group 1: Dimensions appropriate to mounting and interchangeability

Ref.	Limits to be observed			Recommended values for the dimensions mm	Note																				
	Min.	Nom.	Max.																						
n		X			1, 2																				
nD nE		X X																							
A			X	A max. = 1,20, 1,70, 2,00	Includes heat slug Includes package warpage and tilt																				
A1	X	X	X	<table border="1"> <thead> <tr> <th></th> <th>Min.</th> <th>Nom.</th> <th>Max.</th> </tr> </thead> <tbody> <tr> <td>at e = 0,80</td> <td>0,35</td> <td>0,40</td> <td>0,45</td> </tr> <tr> <td>at e = 0,65</td> <td>0,28</td> <td>0,33</td> <td>0,38</td> </tr> <tr> <td>at e = 0,50</td> <td>0,20</td> <td>0,25</td> <td>0,30</td> </tr> <tr> <td>at e = 0,40</td> <td>0,15</td> <td>0,20</td> <td>0,25</td> </tr> </tbody> </table>		Min.	Nom.	Max.	at e = 0,80	0,35	0,40	0,45	at e = 0,65	0,28	0,33	0,38	at e = 0,50	0,20	0,25	0,30	at e = 0,40	0,15	0,20	0,25	
	Min.	Nom.	Max.																						
at e = 0,80	0,35	0,40	0,45																						
at e = 0,65	0,28	0,33	0,38																						
at e = 0,50	0,20	0,25	0,30																						
at e = 0,40	0,15	0,20	0,25																						
øb	X	X	X	<table border="1"> <thead> <tr> <th></th> <th>Min.</th> <th>Nom.</th> <th>Max.</th> </tr> </thead> <tbody> <tr> <td>at e = 0,80</td> <td>0,45</td> <td>0,50</td> <td>0,55</td> </tr> <tr> <td>at e = 0,65</td> <td>0,35</td> <td>0,40</td> <td>0,45</td> </tr> <tr> <td>at e = 0,50</td> <td>0,25</td> <td>0,30</td> <td>0,35</td> </tr> <tr> <td>at e = 0,40</td> <td>0,20</td> <td>0,25</td> <td>0,30</td> </tr> </tbody> </table>		Min.	Nom.	Max.	at e = 0,80	0,45	0,50	0,55	at e = 0,65	0,35	0,40	0,45	at e = 0,50	0,25	0,30	0,35	at e = 0,40	0,20	0,25	0,30	
	Min.	Nom.	Max.																						
at e = 0,80	0,45	0,50	0,55																						
at e = 0,65	0,35	0,40	0,45																						
at e = 0,50	0,25	0,30	0,35																						
at e = 0,40	0,20	0,25	0,30																						
$\square$ $\square$		X X		<p>At flanged type</p> <p>D = 4,0, 5,0, 6,0, 7,0, 8,0, 9,0, 10,0, 11,0, 12,0, 13,0, 14,0, 15,0, 16,0, 17,0, 18,0, 19,0, 20,0, 21,0</p> <p>at type of real chip size</p> <p>D = from 3,1 to 21,0</p> <p>at flanged type</p> <p>E = 4,0, 5,0, 6,0, 7,0, 8,0, 9,0, 10,0, 11,0, 12,0, 13,0, 14,0, 15,0, 16,0, 17,0, 18,0, 19,0, 20,0, 21,0</p> <p>at type of real chip size</p> <p>E = from 3,1 to 21,0</p>	<p>Dimension range shows nominal value</p> <p>Dimension range shows nominal value</p>																				
$\square$		X		e = 0,80, 0,65, 0,50, 0,40																					
v			X	v = 0,15	Includes burrs																				
w			X	<table border="1"> <tbody> <tr> <td>at e = 0,80</td> <td>w = 0,20</td> </tr> <tr> <td>at e = 0,65</td> <td>w = 0,20</td> </tr> <tr> <td>at e = 0,50</td> <td>w = 0,20</td> </tr> <tr> <td>at e = 0,40</td> <td>w = 0,15</td> </tr> </tbody> </table>	at e = 0,80	w = 0,20	at e = 0,65	w = 0,20	at e = 0,50	w = 0,20	at e = 0,40	w = 0,15													
at e = 0,80	w = 0,20																								
at e = 0,65	w = 0,20																								
at e = 0,50	w = 0,20																								
at e = 0,40	w = 0,15																								
x			X	<table border="1"> <tbody> <tr> <td>at e = 0,80</td> <td>x = 0,08</td> </tr> <tr> <td>at e = 0,65</td> <td>x = 0,08</td> </tr> <tr> <td>at e = 0,50</td> <td>x = 0,05</td> </tr> <tr> <td>at e = 0,40</td> <td>x = 0,05</td> </tr> </tbody> </table>	at e = 0,80	x = 0,08	at e = 0,65	x = 0,08	at e = 0,50	x = 0,05	at e = 0,40	x = 0,05													
at e = 0,80	x = 0,08																								
at e = 0,65	x = 0,08																								
at e = 0,50	x = 0,05																								
at e = 0,40	x = 0,05																								

**Table 1 – (continued)**

Ref.	Limits to be observed			Recommended values for the dimensions mm	Note
	Min.	Nom.	Max.		
y			X	at e = 0,80      y = 0,10 at e = 0,65      y = 0,10 at e = 0,50      y = 0,08 at e = 0,40      y = 0,08	
y1			X	y1 = 0,2	
NOTE 1 The values stipulated by the mathematical expression must be applied to the individual overall dimensional standards.					
NOTE 2 Symbol <i>n</i> refers to the total number of terminal positions.					

**Table 2 – Group 2: Dimensions appropriate to mounting and gauging**

Ref.	Limits to be observed			Recommended values for the dimensions mm	Note
	Min.	Nom.	Max.		
øb2			X	at e = 0,80      b2 = 0,63 at e = 0,65      b2 = 0,53 at e = 0,50      b2 = 0,40 at e = 0,40      b2 = 0,35	b2 = bmax. + x
$\begin{matrix} \square \\ e \end{matrix}$		X		e = 0,80, 0,65, 0,50, 0,40	
$\begin{matrix} \square \\ eD \end{matrix}$		X		eD = e × (nD – 1)	
$\begin{matrix} \square \\ eE \end{matrix}$		X		eE = e × (nE – 1)	

**Table 3 – Group 3: Dimensions appropriate to automated handling**

Ref.	Limits to be observed			Recommended values for the dimensions mm	Note
	Min.	Nom.	Max.		
A			X	A max. = 1,20, 1,70, 2,00	Includes heat slug Includes package warpage and tilt
$\begin{matrix} \square \\ D \\ E \end{matrix}$		X		D/E = 4,0, 5,0, 6,0, 7,0, 8,0, 9,0, 10,0, 11,0, 12,0, 13,0, 14,0, 15,0, 16,0, 17,0, 18,0, 19,0, 20,0, 21,0	
y1			X	y1 = 0,2	

**Table 4 – Group 4: Dimensions for information only**

Ref.	Limits to be observed			Recommended values for the dimensions mm	Note
	Min.	Nom.	Max.		
$\begin{matrix} \square \\ ZD \end{matrix}$		X		ZD = (D – e × (nD – 1)) / 2	
$\begin{matrix} \square \\ ZE \end{matrix}$		X		ZE = (E – e × (nE – 1)) / 2	

Table 5 – Dimensions and ball matrix

<b>e = 0,80</b>	<b>Maximum matrix family</b>					<b>Maximum matrix – 1 row family</b>				
<b>E × D</b>	<b>nD</b>	<b>nE</b>	<b>n</b>	<b>ZD</b>	<b>ZE</b>	<b>nD</b>	<b>nE</b>	<b>n</b>	<b>ZD</b>	<b>ZE</b>
4 × 4	4	4	16	0,80	0,80	3	3	9	1,20	1,20
5 × 5	5	5	25	0,90	0,90	4	4	16	1,30	1,30
6 × 6	7	7	49	0,60	0,60	6	6	36	1,00	1,00
7 × 7	8	8	64	0,70	0,70	7	7	49	1,10	1,10
8 × 8	9	9	81	0,80	0,80	8	8	64	1,20	1,20
9 × 9	10	10	100	0,90	0,90	9	9	81	1,30	1,30
10 × 10	12	12	144	0,60	0,60	11	11	121	1,00	1,00
11 × 11	13	13	169	0,70	0,70	12	12	144	1,10	1,10
12 × 12	14	14	196	0,80	0,80	13	13	169	1,20	1,20
13 × 13	15	15	225	0,90	0,90	14	14	196	1,30	1,30
14 × 14	17	17	289	0,60	0,60	16	16	256	1,00	1,00
15 × 15	18	18	324	0,70	0,70	17	17	289	1,10	1,10
16 × 16	19	19	361	0,80	0,80	18	18	324	1,20	1,20
17 × 17	20	20	400	0,90	0,90	19	19	361	1,30	1,30
18 × 18	22	22	484	0,60	0,60	21	21	441	1,00	1,00
19 × 19	23	23	529	0,70	0,70	22	22	484	1,10	1,10
20 × 20	24	24	576	0,80	0,80	23	23	529	1,20	1,20
21 × 21	25	25	625	0,90	0,90	24	24	576	1,30	1,30
<b>e = 0,65</b>	<b>Maximum matrix family</b>					<b>Maximum matrix – 1 row family</b>				
<b>E × D</b>	<b>nD</b>	<b>nE</b>	<b>n</b>	<b>ZD</b>	<b>ZE</b>	<b>nD</b>	<b>nE</b>	<b>n</b>	<b>ZD</b>	<b>ZE</b>
4 × 4	5	5	25	0,700	0,700	4	4	16	1,025	1,025
5 × 5	7	7	49	0,550	0,550	6	6	36	0,875	0,875
6 × 6	8	8	64	0,725	0,725	7	7	49	1,050	1,050
7 × 7	10	10	100	0,575	0,575	9	9	81	0,900	0,900
8 × 8	11	11	121	0,750	0,750	10	10	100	1,075	1,075
9 × 9	13	13	169	0,600	0,600	12	12	144	0,925	0,925
10 × 10	14	14	196	0,775	0,775	13	13	169	1,100	1,100
11 × 11	16	16	256	0,625	0,625	15	15	225	0,950	0,950
12 × 12	17	17	289	0,800	0,800	16	16	256	1,125	1,125
13 × 13	19	19	361	0,650	0,650	18	18	324	0,975	0,975
14 × 14	20	20	400	0,825	0,825	19	19	361	1,150	1,150
15 × 15	22	22	484	0,675	0,675	21	21	441	1,000	1,000
16 × 16	23	23	529	0,850	0,850	22	22	484	1,175	1,175
17 × 17	25	25	625	0,700	0,700	24	24	576	1,025	1,025
18 × 18	27	27	729	0,550	0,550	26	26	676	0,875	0,875
19 × 19	28	28	784	0,725	0,725	27	27	729	1,050	1,050
20 × 20	30	30	900	0,575	0,575	29	29	841	0,900	0,900
21 × 21	31	31	961	0,750	0,750	30	30	900	1,075	1,075