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PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD

Mechanical standardization of semiconductor devices – Part 6-18: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Design guide for ball grid array (BGA)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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Part 6-18: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Design guide for ball grid array (BGA)

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The text of this PAS is based on the following documents	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:
Draft PAS	Report on voting
47D/677/NP	47D/701/RVN

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MECHANICAL STANDARDIZATION OF SEMICONDUCTOR DEVICES –

Part 6-18: General rules for the preparation of outline drawings of surface mounted semiconductor device packages – Design guide for ball grid array (BGA)

1 Scope

This PAS provides common outline drawings and dimensions for all types of structures and composed materials of ball grid array (hereinafter called BGA), whose terminal pitch is one millimetre or larger and whose package body outline is square.

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.

None.

3 Terms and definitions

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

3.1
ball grid array
BGA
low-profile package whose terminals are metal balls located on one surface in a matrix of at least three rows and three columns; terminals may be missing from some row-column intersections

NOTE BGA stands for "Ball Grid Array" in this standard to be aligned with IEC 60191-6-2, 60191-6-4, and 60191-6-5. Only IEC 60191-4 refers BGA as "Bottom Grid Array", and it is not common language in the industry and no other standard uses this name.

3.2
plastic ball grid array
P-BGA
BGA whose substrate is made of organic printed wiring board

3.3
tape ball grid array
T-BGA
BGA whose substrate is made of polyimide tape

3.4
ceramic ball grid array
C-BGA
BGA whose substrate is made of ceramic circuit board

3.5
P-BGA (flip chip interconnection)
BGA whose substrate is made of organic printed wiring board and is connected to the die by the bumps on the die

3.6
Recommended BGA variations
BGA variations that shall be considered to be the first choice for production

Package variations other than recommended BGA variations are not recommended to prevent the endless proliferation of the BGA variations.

4 Terminal position numbering

When a package is viewed from the terminal side with the index corner in the bottom left corner position, terminal rows are lettered from bottom to top starting with A, then B, C, ... AA, AB, etc., while terminal columns are numbered from left to right starting with 1. Terminal positions are designated by a row-column grid system and shown as alphanumeric identification, e.g., A1, B1, or AC34. The letters I, O, Q, S, X and Z are not used for naming the terminal rows.

5 Nominal package dimension

A nominal package dimension is defined as “the package width (E) X length (D)”, which is expressed to the tenth place, in millimetres.

6 Symbols and drawings

6.1 BGA outline

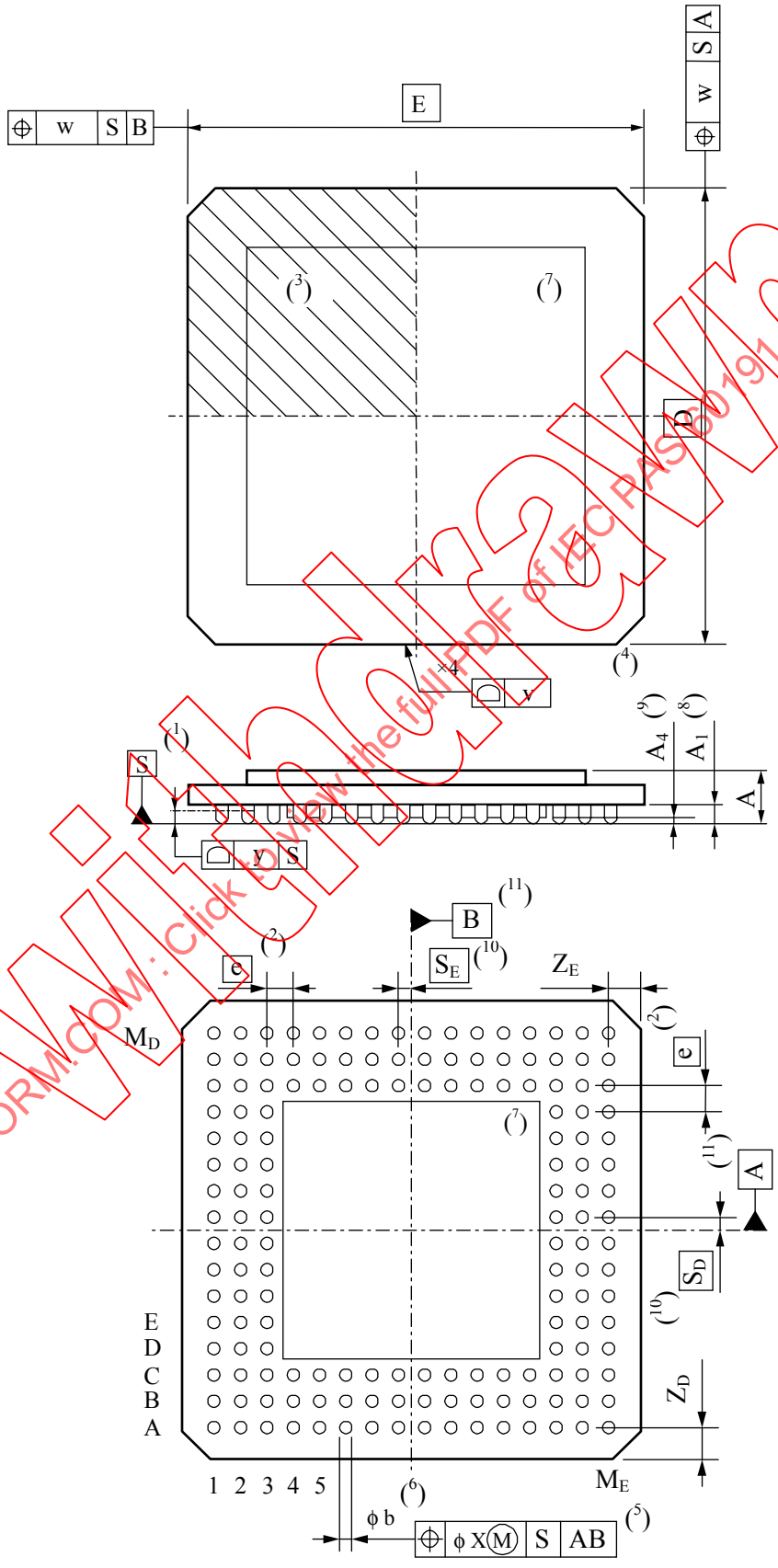


Figure 1 – Cavity down type

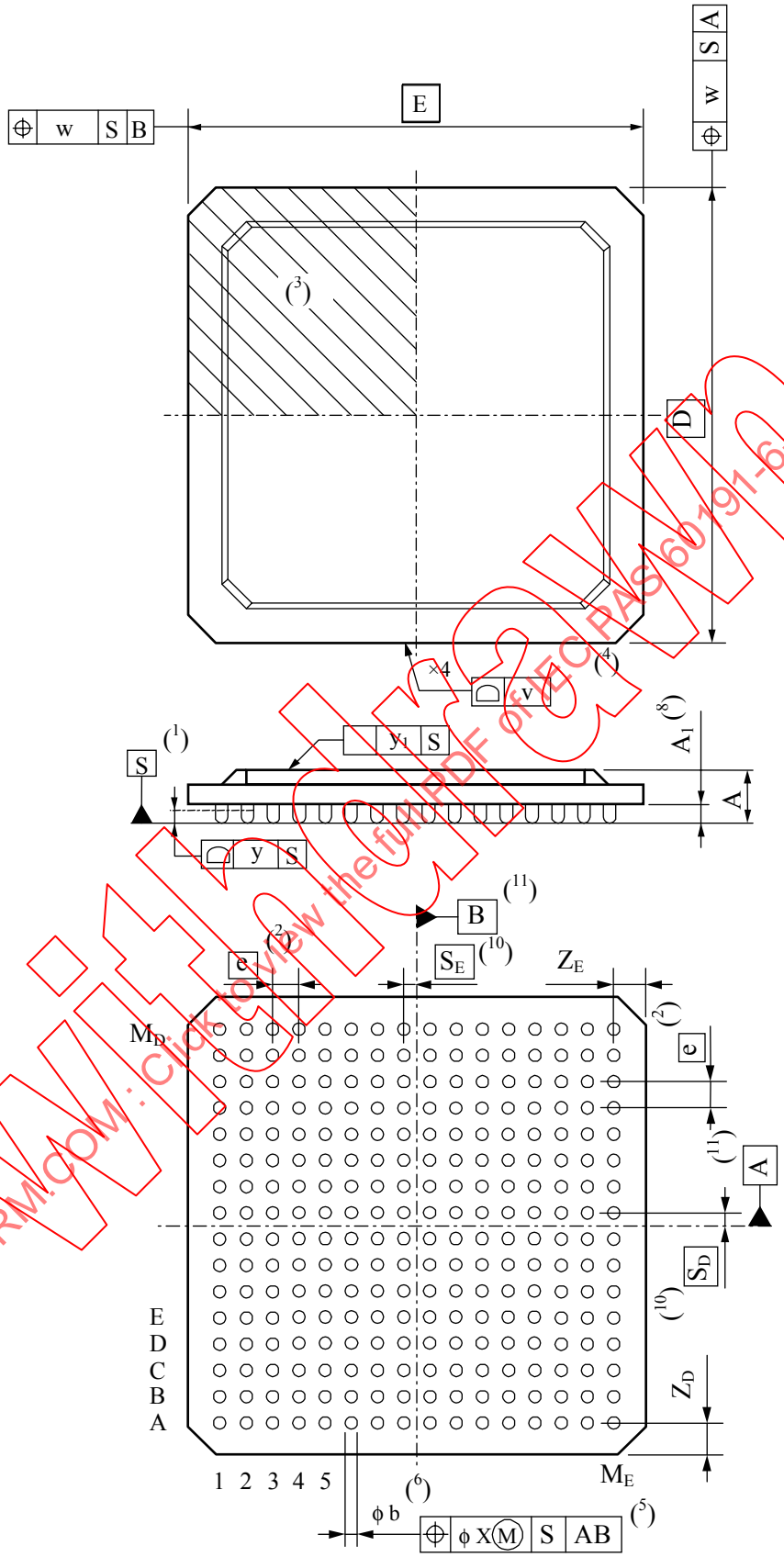


Figure 2 – Cavity up type

NOTE 1 Datum S is defined as the seating plane on which a package free stands by contact of the balls.

NOTE 2 The distance between the centerlines of any two adjacent rows or columns of balls.

NOTE 3 The hatched zone indicates the index-marking area where whole index mark will be contained.

NOTE 4 The profile tolerance that controls of package size and orientation is applied to all four sides of the package outline.

NOTE 5 The tolerance of position that controls the relationship of the balls applies to all balls.

NOTE 6 The terminal diameter “b” is the maximum diameter of individual balls as measured in the plane parallel to the seating plane.

NOTE 7 It shows the lid made of mold compound, glob top resin, metal cap, ceramics, etc. It may be flat, convex or concave in shape.

NOTE 8 The primary stand-off height is defined by the height from seating plane to the package substrate.

NOTE 9 The secondary stand-off height is defined by the height from the seating plane to the lid that is the lowest surface on the cavity-down configuration.

NOTE 10 S_D and S_E are the dimensions that define the positions of balls next to the datum A and B.

NOTE 11 Datum A and B are defined by the most outer balls which locate in the middle of all four sides.

Remarks: An array pattern of permissible terminal-existing zones including true position tolerance is shown in Figure 3.

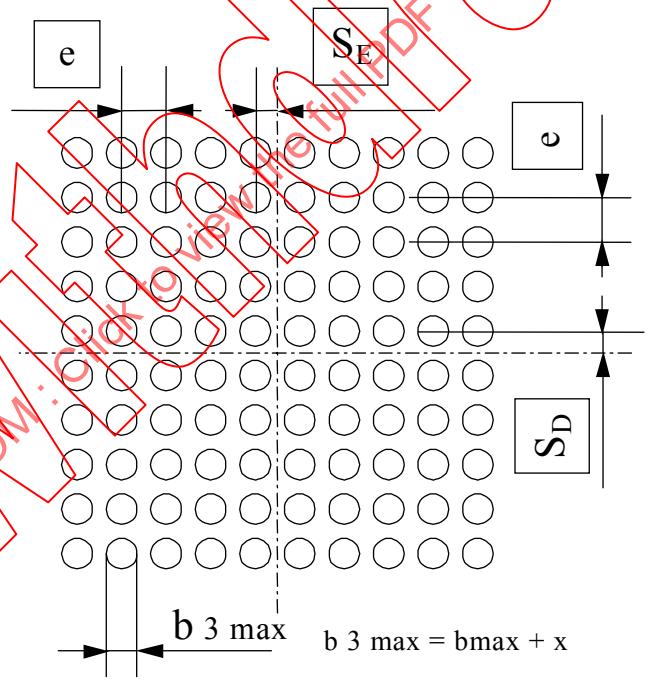


Figure 3 – Pattern of terminal position areas

7 Dimensions

7.1 Group 1

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

Term	Symbol	Specification mm	Recommended value
Nominal package dimension	E × D	(1) A nominal package dimension is defined as "the package width (E) x length (D)", which is expressed to the tenth place, in millimetres. (2) Variations on nominal package dimensions are: 7,0×7,0 25,0×25,0 8,0×8,0 27,0×27,0 9,0×9,0 29,0×29,0 10,0×10,0 31,0×31,0 11,0×11,0 33,0×33,0 12,0×12,0 35,0×35,0 13,0×13,0 37,5×37,5 14,0×14,0 40,0×40,0 15,0×15,0 42,5×42,5 16,0×16,0 45,0×45,0 17,0×17,0 47,5×47,5 18,0×18,0 50,0×50,0 19,0×19,0 52,5×52,5 20,0×20,0 55,0×55,0 21,0×21,0 57,5×57,5 23,0×23,0 60,0×60,0	Refer to Tables 5 through 10
Package length	D	(1) Package length D 7,0 25,0 8,0 27,0 9,0 29,0 10,0 31,0 11,0 33,0 12,0 35,0 13,0 37,5 14,0 40,0 15,0 42,5 16,0 45,0 17,0 47,5 18,0 50,0 19,0 52,5 20,0 55,0 21,0 57,5 23,0 60,0	Refer to Tables 5 through 10

Table 1 *(continued)*

<table>
<tr><th>Term</th><th>Symbol</th><th>Specification
mm</th><th>Recommended value</th></tr>
<tr><td>Package width</td><td>E</td><td>(1) Package width E
7,0 25,0
8,0 27,0
9,0 29,0
10,0 31,0
11,0 33,0
12,0 35,0
13,0 37,5
14,0 40,0
15,0 42,5
16,0 45,0
17,0 47,5
18,0 50,0
19,0 52,5
20,0 55,0
21,0 57,5
23,0 60,0</td><td>Refer to Tablex 5 through 10</td></tr>
<tr><td>Profile tolerance of package body</td><td>v</td><td>v = 0,20
Profile tolerance includes body-edge burr</td><td>-</td></tr>
<tr><td>Off-centre tolerance</td><td>w</td><td><table><tr><th>e</th><th>w</th></tr><tr><td>1,27</td><td>0,30</td></tr><tr><td>1,00</td><td>0,30</td></tr></table></td><td>-</td></tr>
<tr><td>Profile height</td><td>A</td><td><table><tr><th>A max</th></tr><tr><td>1,20</td></tr><tr><td>1,70</td></tr><tr><td>6,00</td></tr></table>”A” includes heat slug thickness, package warpage and tilt errors.
“A” does not include the height of external heat sink or chip capacitors.</td><td>-</td></tr>
<tr><td>Primary stand-off height</td><td>A1</td><td><table><tr><th>e</th><th>A1 min</th><th>A1 nom</th><th>A1 max</th></tr><tr><td>1,27</td><td>0,5</td><td>0,6</td><td>0,7</td></tr><tr><td>1,00</td><td>0,4</td><td>0,5</td><td>0,6</td></tr></table></td><td>-</td></tr>
</table>

Table 1 *(continued)*

<table>
<tr><th>Term</th><th>Symbol</th><th>Specification
mm</th><th>Recommended value</th></tr>
<tr><td>Secondary stand-off height</td><td>A_4</td><td>$A_{4\ min}$ = 0,25</td><td>-</td></tr>
<tr><td>Terminal grid pitch</td><td>e</td><td>1,27
1,00</td><td>-</td></tr>
<tr><td>Terminal diameter</td><td>b</td><td><table><tr><th>e</th><th>b_{min}</th><th>b_{nom}</th><th>b_{max}</th></tr><tr><td>1,27</td><td>0,60</td><td>0,75</td><td>0,90</td></tr><tr><td>1,00</td><td>0,50</td><td>0,60</td><td>0,70</td></tr></table></td><td>-</td></tr>
<tr><td>True position tolerance</td><td>x</td><td><table><tr><th>e</th><th>x</th></tr><tr><td>1,27</td><td>0,15</td></tr><tr><td>1,00</td><td>0,10</td></tr></table></td><td>-</td></tr>
<tr><td>Co-planarity</td><td>y</td><td><table><tr><th>e</th><th>y</th></tr><tr><td>1,27</td><td>0,20</td></tr><tr><td>1,00</td><td>0,20</td></tr></table></td><td>-</td></tr>
<tr><td>Parallelism tolerance of the top surface</td><td>y_1</td><td>y_1 = 0,35</td><td>-</td></tr>
<tr><td>Centre terminal(s) position in length</td><td>S_D</td><td>When M_D is an odd number, S_D = 0.
When M_D is an even number, S_D = e /2</td><td>-</td></tr>
<tr><td>Centre terminal(s) position in width</td><td>S_E</td><td>When M_E is an odd number, S_E = 0.
When M_E is even number, S_E = e /2</td><td>-</td></tr>
<tr><td>Terminal matrix</td><td></td><td>Terminal balls will be placed on the matrix determined by terminal pitch e, matrix size M_D and M_E, and centre ball position S_D and S_E. Any terminal balls may be omitted from the terminal matrix.</td><td>-</td></tr>
<tr><td>Number of terminals</td><td>n</td><td>Refer to Table 3</td><td>Refer to Tables 5 through 10</td></tr>
<tr><td>Maximum matrix size in length</td><td>M_D</td><td></td><td></td></tr>
<tr><td>Maximum matrix size in width</td><td>M_E</td><td></td><td></td></tr>
</table>

7.2 Group 2

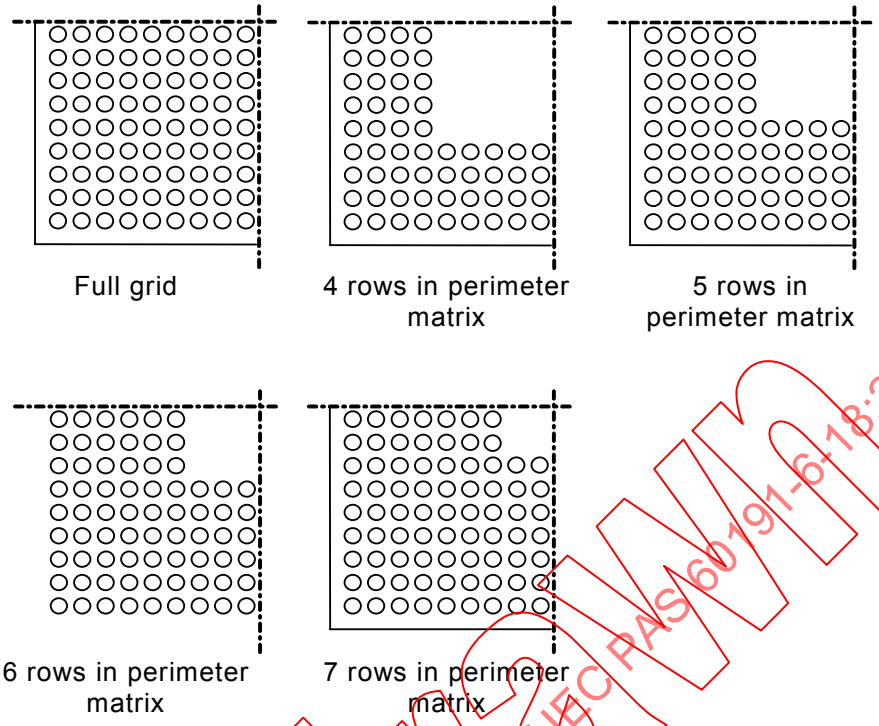
Table 2 – Group 2: Dimensions appropriate to mounting and gauging

Term	Symbol	Specification mm	Recommended value
Overhang dimension in length	Z_D	$Z_D = \{ D -(M_D -1) \times e \} / 2$	-
Overhang dimension in width	Z_E	$Z_E = \{ E -(M_E -1) \times e \} / 2$	-

Table 3 – Combinations of D, E, e, M_D, M_E, and n

D and E	e 1,27				e = 1,00			
	$M_{D\ max}$ $M_{E\ max}$	n_{max}	$M_{D\ max-1}$ $M_{E\ max-1}$	n_{max}	$M_{D\ max}$ $M_{E\ max}$	n_{max}	$M_{D\ max-1}$ $M_{E\ max-1}$	n_{max}
7,0	5	25	4	16	6	36	5	25
8,0	6	36	5	25	7	49	6	36
9,0	6	36	5	25	8	64	7	49
10,0	7	49	6	36	9	81	8	64
11,0	8	64	7	49	10	100	9	81
12,0	9	81	8	64	11	121	10	100
13,0	10	100	9	81	12	144	11	121
14,0	10	100	9	81	13	169	12	144
15,0	11	121	10	100	14	196	13	169
16,0	12	144	11	121	15	225	14	196
17,0	13	169	12	144	16	256	15	225
18,0	13	169	12	144	17	289	16	256
19,0	14	196	13	169	18	324	17	289
20,0	15	225	14	196	19	361	18	324
21,0	16	256	15	225	20	400	19	361
23,0	18	324	17	289	22	484	21	441
25,0	19	361	18	324	24	576	23	529
27,0	21	441	20	400	26	676	25	625
29,0	22	484	21	441	28	784	27	729
31,0	24	576	23	529	30	900	29	841
33,0	25	625	24	576	32	1024	31	961
35,0	27	729	26	676	34	1156	33	1089
37,5	29	841	28	784	37	1369	36	1296
40,0	31	961	30	900	39	1521	38	1444
42,5	33	1089	32	1024	42	1764	41	1681
45,0	35	1225	34	1156	44	1936	43	1849
47,5	37	1369	36	1296	47	2209	46	2116
50,0	39	1521	38	1444	49	2401	48	2304
52,5	41	1681	40	1600	52	2704	51	2601
55,0	43	1849	42	1764	54	2916	53	2809
57,5	45	2025	44	1936	57	3249	56	3136
60,0	47	2209	46	2116	59	3481	58	3364

NOTE "n_{max}" indicates the maximum number of terminals that can be accommodated in a package bottom. The actual number of the terminals may be less than n_{max} by de-populating terminals from the full matrix.



NOTE – Index marking is in the bottom left corner.

Figure 4 – Example of terminal de-populations

8 Recommended BGA variations

Table 4 P-BGA (Cavity up) 1,27mm pitch

D and E	M	e	Number of rows in perimeter matrix	Number of rows in centre matrix	Number of terminals
27	20	1,27	4	0	256
27	20	1,27	4	4	272
27	20	1,27	5	0	300
27	20	1,27	5	4	316
27	20	1,27	6	0	336
27	20	1,27	6	4	352
31	23	1,27	4	0	304
31	23	1,27	4	5	329
31	23	1,27	5	0	360
31	23	1,27	5	5	385
31	23	1,27	6	0	408
31	23	1,27	6	5	433
35	26	1,27	4	0	352
35	26	1,27	4	6	388
35	26	1,27	5	0	420
35	26	1,27	5	6	456
35	26	1,27	6	0	480
35	26	1,27	6	6	516
40	30	1,27	6	0	576
40	30	1,27	6	8	640
40	30	1,27	7	0	644
40	30	1,27	7	8	708

Table 5 – P-BGA (Cavity up) 1,0 mm pitch

D and E	M	e	Number of rows in perimeter matrix	Number of rows in centre matrix	Number of terminals
13	12	1,00	Full	Full	144
14	13	1,00	Full	Full	169
15	14	1,00	Full	Full	196
16	15	1,00	Full	Full	225
17	16	1,00	Full	Full	256
18	17	1,00	Full	Full	289
19	18	1,00	Full	Full	324
20	19	1,00	Full	Full	361
21	20	1,00	4	0	256
21	20	1,00	4	6	292
21	20	1,00	Full	Full	400
23	22	1,00	4	0	288
23	22	1,00	4	6	324
23	22	1,00	5	0	340
23	22	1,00	5	6	376
23	22	1,00	6	0	384
23	22	1,00	6	6	420
23	22	1,00	Full	Full	484
27	26	1,00	4	0	352
27	26	1,00	4	6	388
27	26	1,00	5	0	420
27	26	1,00	5	6	456
27	26	1,00	6	0	480
27	26	1,00	6	6	516
27	26	1,00	Full	Full	676
31	30	1,00	4	0	416
31	30	1,00	4	6	452
31	30	1,00	5	0	500
31	30	1,00	5	6	536
31	30	1,00	6	0	576
31	30	1,00	6	6	612
31	30	1,00	Full	Full	900
35	33	1,00	4	0	464
35	33	1,00	4	9	545
35	33	1,00	5	0	560
35	33	1,00	5	9	641
35	33	1,00	6	0	648
35	33	1,00	6	9	729
35	33	1,00	7	0	728
35	33	1,00	7	9	809
35	33	1,00	Full	Full	1089
37,5	36	1,00	4	0	512
37,5	36	1,00	4	10	612
37,5	36	1,00	5	0	620
37,5	36	1,00	5	10	720
37,5	36	1,00	6	0	812
37,5	36	1,00	6	10	912
37,5	36	1,00	7	0	896
37,5	36	1,00	7	10	996
37,5	36	1,00	Full	Full	1296
40	38	1,00	6	0	768
40	38	1,00	6	10	868
40	38	1,00	7	0	868
40	38	1,00	7	10	968
40	38	1,00	Full	Full	1444

Table 6 – P-BGA (Cavity down) 1,27 mm pitch

D and E	M	e	Number of rows in perimeter matrix	Number of terminals
27	20	1,27	4	256
31	23	1,27	4	304
35	26	1,27	4	352
35	26	1,27	5	420
40	30	1,27	4	416
40	30	1,27	5	500
40	30	1,27	6	576
42,5	32	1,27	5	540
45	34	1,27	4	480
45	34	1,27	5	580
45	34	1,27	6	672
45	34	1,27	7	756

Table 7 – T-BGA 1,27 mm pitch

D and E	M	e	Number of rows in perimeter matrix	Number of terminals
27	20	1,27	4	256
31	23	1,27	4	304
35	26	1,27	4	352
35	26	1,27	5	420
35	26	1,27	6	480
40	30	1,27	5	500
40	30	1,27	6	576
40	30	1,27	7	644

Table 8 – T-BGA 1,0 mm pitch

D and E	M	e	Number of rows in perimeter matrix	Number of terminals
27	25	1,0	4	336
31	29	1,0	4	400
31	29	1,0	5	480
31	29	1,0	6	552
35	33	1,0	4	464
35	33	1,0	5	560
35	33	1,0	6	648
40	38	1,0	5	660
40	38	1,0	6	768
40	38	1,0	7	868