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**D E C I S I O N**  
**of 10 January 2001**

**Case Number:** T 0988/99 - 3.4.2

**Application Number:** 92117863.8

**Publication Number:** 0546285

**IPC:** H05K 3/28, H01L 21/00, H05K 13/00

**Language of the proceedings:** EN

**Title of invention:**  
Electronic package assembly with protective encapsulant material

**Patentee:**  
INTERNATIONAL BUSINESS MACHINES CORPORATION

**Opponent:**  
Mannesmann VDO AG

**Headword:**  
-

**Relevant legal provisions:**  
EPC Art. 56

**Keyword:**  
"Inventive step (yes)"

**Decisions cited:**  
G 0010/91

**Catchword:**  
-



Case Number: T 0988/99 - 3.4.2

**D E C I S I O N**  
**of the Technical Board of Appeal 3.4.2**  
**of 10 January 2001**

**Appellant:** INTERNATIONAL BUSINESS MACHINES CORPORATION  
(Proprietor of the patent) Armonk, NY 10504 (US)

**Representative:** Rach, Werner, Dr.  
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**Respondent:** Mannesmann VDO AG  
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**Representative:** Klein, Thomas, Dipl.-Ing.  
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**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 9 September 1999  
revoking European patent No. 0 546 285 pursuant  
to Article 102(1) EPC.

**Composition of the Board:**

**Chairman:** E. Turrini  
**Members:** A. G. Klein  
V. Di Cerbo

## Summary of Facts and Submissions

I. European patent No. 0 546 285 (application No. 92 117 863.8) was granted with a set of claims of which claims 1 and 12, the only independent claims, read as follows:

"1. An electronic package assembly (10) comprising:

an organic substrate (11) including a surface (19) thereon having a plurality of electrical conductors (17) positioned on said surface;

an electronic package including an elongated,

electrically insulative housing (31) having a lower surface being located at a slight gap of between  $2.54 \times 10^{-5}$  and  $7.62 \times 10^{-5}$  m (0.001 and 0.003 inch) above said surface of said organic substrate and further including a singular, planar upper surface (37) and first (33, 34) and second (35, 36) opposing sides, said package further including first and second pluralities of electrically conductive leads (21) projecting from said first and second opposing sides, respectively, and electrically connected to respective ones of said electrical conductors on said surface of said substrate,

said projecting leads not being located between said lower surface of said insulative housing and said surface of said organic substrate;

a plurality of quantities of solder (53), each quantity of solder substantially covering one of said conductive leads (21) and at least a portion of a respective one of said electrical conductors (17) to provide an electrical connection therebetween; and

encapsulant material (61) located on said quantities of solder and substantially covering said solder, said encapsulant material positioned against said first and second opposing sides in an abutting relationship and substantially preventing electrical disconnection between said projecting conductive leads and said solder during operation of said electronic package assembly,

said disconnection caused by stresses occurring due to differences in the coefficients of thermal expansion of said organic substrate (11), solder (53) and conductive leads (21) during said operation, said encapsulant material (61) not being located on said singular, planar upper surface (37) of said insulative housing (31).

"12. A method of making an electronic package assembly (10), said method comprising:

providing an organic substrate (11) including a surface (19) thereon having a plurality of electrical conductors (17) positioned on said surface;

positioning an electronic package including an elongated, electrically insulative housing (31) having a lower surface (38) and an upper surface

(37) and further including first and second pluralities of electrically conductive leads (21) projecting from said first and

second opposing sides, respectively, such that said lower surface (38) of said housing is located  $7.62 \times 10^{-5}$  m (0.003 inch) above said surface of said substrate (11) and said conductive leads (21) are electrically connected to respective ones of said electrical conductors (17) on said surface of said substrate;

substantially covering each of said conductive leads and at least a portion of a respective electrical conductor with a quantity of solder, said solder providing an electrical connection between said lead and respective conductor; and

substantially covering said solder (53) with encapsulant material (61), and further positioning said encapsulant material against said first (33, 34) and second (35, 36) opposing sides of said housing (31) in an abutting manner, said encapsulant material substantially preventing electrical disconnection between said projecting conductive leads (21) and said solder during operation of said electronic package assembly (10), said disconnection caused by stresses occurring due to differences in the coefficients of thermal expansion of said organic substrate (11), solder and conductive leads during said operation, said encapsulant material not being located on said upper surface (37) of said insulative housing."

II. Following an opposition founded on the ground that the subject-matter of the European patent was not patentable within the terms of Articles 52 to 57 in view of the contents of the following documents:

E1: US-A-4 238 528

E2: US-A-4 830 922

E3: EP-A-0 446 666

E4: Das SMT-Handbuch, Texas Instruments Deutschland GmbH, 1986; pages 14 to 23, 38 to 55, 190 to 195 and 257

the patent was revoked by the Opposition Division.

The Opposition Division held in its decision that the subject-matter of claim 1 was distinguished from the electronic package assembly disclosed in document E2, considered to constitute the closest prior art, in that the gap between the lower surface of the housing and the upper surface of the organic substrate was specified to lie between 25.4 and 76.2  $\mu\text{m}$ . Such gap size was a conventional feature, as was clear from document E4 (see point 3 of the Reasons).

III. The appellant (proprietor of the patent) lodged an appeal against the Opposition Division's decision, requesting that it be set aside and that the patent be maintained unamended.

The respondent (opponent) requested that the appeal be dismissed.

- IV. Oral proceedings were held on 10 January 2001, at the end of which the Board announced its decision.
  
- V. In support of his requests the appellant submitted that the invention related to the mounting of low profile electronic packages, referred to in the art as TSOP's (thin small outline packages), onto organic substrates provided with a plurality of electrical conductors, with a small gap therebetween. Such assemblies were prone to separation of the connection between the electrically conductive leads projecting from the package and the electrical conductors on the organic substrate, due to thermal stress resulting from significant differences in the coefficients of thermal expansion (CTE) of the various components.

This problem was solved in accordance with the invention by providing quantities of solder material in excess onto the individual leads, so as to almost substantially entirely surround them with solder. A solid mass of encapsulant material was then formed over said quantities of solder to substantially cover them and positioned in abutting relationship against the side walls of the housing, so as to stabilize the assembly. Since the CTE of the encapsulant material was closer to that of solder material than to that of the alloy materials used for the conductive leads, the mechanical connection between the lead and the solder material being itself inherently very strong, the presence of an intermediate layer of solder material substantially improved the mechanical stability of the whole assembly.

This solution was not suggested by the prior art.

Document E4 in particular pointed at a different direction, since it suggested the selection of materials for the package components which exhibited a similar CTE, and the avoidance of excessive quantities of solder material on the leads.

Document E2 did not address the technical problem of thermally induced stress, and the soft, conformable encapsulant material disclosed there for protecting electronic package from humidity and chemical corrosion did not provide any mechanical stabilization.

Document E3 related to the direct mounting of integrated circuits onto an organic substrate via solder bumps, without any connecting leads.

- VI. The respondent for his part submitted that the closest prior art was disclosed in document E2, which in fact contained two different teachings. The document indeed disclosed and claimed a soft, conformable encapsulant material. In connection with the description of the background art in the first paragraph of column 2, it however also disclosed the use of the solid encapsulant material encompassed by the patent in suit, in circumstances involving temperature changes.

Concerning the provision of solder on the individual connection leads, the reference in the claims to quantities of solder "substantially covering" the leads did not actually define any limitation. Such substantive covering necessarily resulted from the surface tension of the heated liquid solder material. This surface tension always caused substantial covering of the conductive leads with menisci of solder material being formed at the edges, as was evident for instance



from the photographs on page 246 of document E4.

Figure 1 of the patent in suit which illustrated an electronic package assembly of the alleged invention prior to having an encapsulant material adhered thereto, did not show any excess quantities of solder materials on the conductive leads either.

A gap in the claimed range between the housing of an electronic package and the organic substrate on which it was mounted was disclosed on page 257 of document E4 and referred to there as "Stand-off".

The respondent also objected to the admissibility under Article 123(2) EPC of the specification of such gap in the independent claims. This feature had not been set out in any of the claims as originally filed, and there was no indication in the original application documents that the presence of the gap, which was referred to there only casually, was of any technical importance whatsoever.

### **Reasons for the Decision**

1. The appeal is admissible.
2. *Ground for opposition under Article 100(c) EPC*

The respondent raised his objection that the specification of a gap in the independent claims as granted extended the subject-matter of the European patent beyond the content of the application as filed, for the first time in his letter dated 11 December 2000, i.e. during the appeal proceedings and after the

filing of the statement of grounds of appeal.

Accordingly, taking into account, inter alia, the principles laid down by the Enlarged Board of Appeal in the opinion G 10/91 (OJ EPO, 1993, 420, see in particular point 18 of the Reasons), the Board does not consent to this fresh ground for opposition being introduced into the present appeal procedure.

3. *Proper construction of claim 1*

3.1 Claim 1 does not explicitly specify the consistence of the encapsulant material it refers to. The claim however indicates the technical function exerted by that material when located on the quantities solder so as to substantially cover them and positioned in an abutting relationship against the opposing sides of the housing. This function consists in substantially preventing electrical disconnection caused by stresses occurring due to differences in the CTE of the various components.

This functional definition in the Board's view implies that the encapsulant material in operation forms a **solid** mass which is firmly adhered to the housing, solder and substrate so as to constitute therewith a rigid, integral assembly.

This construction of claim 1 was not contested by the respondent.

3.2 Claim 1 further refers to each quantity of solder "substantially covering one of said conductive leads".

The description of the patent in suit in this respect

explicitly states that "the configuration for solder 53 as depicted in Figure 3 shows the solder to substantially cover the pin 21, **almost substantially entirely surrounding the pin**" (emphasis added, see page 4, lines 39 to 40). The respondent pointed at Figure 1 which as a matter of fact does not show quantities of solder which substantially entirely surround the pin. However, the description of the patent in suit clearly specifies that no solder is shown in Figure 1, **for clarity** (see page 4, lines 30 and 31).

Accordingly, the feature of each quantity of solder substantially covering one of said conductive leads in the Board's opinion shall be construed to the effect that the solder is so applied to each conductive lead that virtually no portion thereof remains uncovered by solder.

4. *Novelty of the subject-matter of claim 1*

4.1 Document E2 discloses an electronic package assembly which comprises an electrically insulative housing 14 with a plurality of electrically conductive leads projecting from opposing sides, mounted on the surface of an organic substrate 10. Encapsulant material 16 substantially covers the leads and is positioned in an abutting relationship against the sides of the electrically insulative housing (see Figures 1 and 2 and column 3, lines 4 to 48).

The description and figures of document E2 do not disclose any gap between the lower surface of the electronic package housing and the upper surface of the substrate, nor any substantial covering of each lead

with respective quantities of solder, as is set out in claim 1. In the side elevation view of document E2, in particular, the interface between the lower portion of housing 14 and the substrate 10 is masked by encapsulant material 16, and the leads projecting from the right side of the housing are substantially devoid of any solder material.

In further contrast with the claimed subject-matter, the conformable encapsulant material of document E2, which comprises a carrier selected from dielectric hydrocarbon greases, is of a **viscous** consistence, as is expressly set out in claim 1 of E2. Whilst the document stresses that the proposed encapsulant material prevents the access to the electronic package assembly of moisture, corrosive elements or dust (see column 3, lines 20 to 26), and that it exerts such protective effect even "under circumstances involving vibration, temperature changes and shock" (see column 1, lines 56 to 60 and column 4, lines 51 to 58), there is no indication that the encapsulant itself prevents thermally induced disconnection of the lead-solder joint by strengthening the structure, as is set out in present claim 1.

The respondent pointed at a passage in document E2 referring to the background art and stating that many commercially available conformal protecting coatings contained silicon compounds or resins that hardened after application and were hard to remove (see column 2, lines 1 to 3). This passage does not however disclose any specific constructive features of an electronic package assembly. Whether this prior art encapsulant material mentioned in the passage would be applied to the electronic package assembly disclosed

later in the document is a matter of inventive step, not of novelty.

- 4.2 Document E4 discloses the mounting onto an organic substrate provided with surface conductors of an electronic package including an electrically insulative housing with electrically conductive leads projecting from its sides and electrically connected to the electrical conductors on the surface of the substrate. A plurality of quantities of solder, each provided on a projecting lead and on the associated electrical conductor on the substrate, provide for an electrical connection therebetween (see in particular the photograph on page 246).

Whilst other portions of document E4, in particular the figures on page 257 actually describe an electronic package housing with projecting leads so configured as to allow for a slight gap in the claimed range between the lower surface of the housing and the facing surface of the organic substrate on which it is to be mounted, this feature is not clearly disclosed in the embodiment of the photograph on page 246. Neither does this photograph in the Board's opinion clearly show that each conductive lead is "substantially covered" by a quantity of solder within the meaning of claim 1 as set out in point 3.2 above, and there is provided no encapsulant material.

- 4.3 The remaining documents on the file do not come closer to the subject-matter of claim 1. The electronic package assemblies of documents E1 and E3 in particular do not comprise any leads projecting from the sides of an electrically insulative housing. On the contrary, solder bumps directly connect conductive pads formed

under the lower surface of an integrated circuit chip to connecting pads on an organic substrate.

4.4 For these reasons, the subject-matter of claim 1 is novel within the meaning of Article 54 EPC.

5. *Inventive step involved by the subject-matter of claim 1*

5.1 The closest prior art in the Board's view is constituted by the electronic package assembly shown on page 246 of document E4, rather than by the assembly shown in Figures 1 and 2 of document E2, as was assumed by the Opposition Division.

As a matter of fact, it is an essential characteristic of the encapsulant material proposed in document E2 that it has a soft consistence. The Board cannot therefore endorse the Opposition Division's view, that this material "will have the effect of preventing electrical disconnection of the leads from the conductors during operation of the assembly caused by stresses occurring due to differences in the coefficients of thermal expansion of the respective components, in the sense of the claim wording" (see the sentence at the end of the first paragraph of point 3.1 of the Reasons).

5.2 The electronic package assembly of present claim 1 is distinguished from the closest prior art assembly of document E4 firstly in that the lower surface of the electrically insulative housing is located at a slight gap of between  $2.54 \times 10^{-5}$  and  $7.62 \times 10^{-5}$  m above the surface of the organic substrate.

A slight gap in the range defined in claim 1 is known from the figures on page 257 of document E4 and providing such a gap also in the embodiment of page 246 of the same document does not as such involve any inventive step, as was admitted also by the appellant at the oral proceedings. Such slight gap clearly warrants a proper contact between the ends of the respective conductive leads projecting from the housing and the corresponding conductors on the organic substrate, when the electronic package is placed onto the substrate, by preventing the lower surface of the housing from touching the substrate before the contact is established between the ends of the leads and the conductors on the substrate.

- 5.3 The electronic package assembly of claim 1 is further distinguished from the closest prior art as disclosed in document E4 by the use of a solid encapsulant material which covers the projecting conductive leads and is positioned against the lateral sides of the housing in an abutting relationship.

The use of such solid material, at least as a protection against chemical corrosion, moisture and mechanical fatigue or shock, would not appear to involve an inventive step either. Such use was indeed known in the art as is evidenced by the passage of the description of the background art in document E2 relied upon by the respondent (see column 2, lines 1 to 3).

- 5.4 However, the subject-matter of present claim 1 is still further distinguished from the electronic package assembly shown on the photograph on page 246 of document E4 in that quantities of solder "substantially cover" the respective conductive leads projecting from

the electronic package housing within the meaning set out in point 3.2 above, such quantities of solder being themselves substantially covered by encapsulant material.

The Board has no reason to question the appellant's submission, supported by the CTE values given in the table on page 5 of the specification of the patent in suit and not contested by the respondent, that the closeness of the CTE values for solder and encapsulant material results in a reduction of thermally induced stress at the interface between the encapsulant material and the underlying element, as compared to the stress which would occur if the encapsulant material was provided in direct contact with the conductive leads. The greater difference of the CTE values for the solder material and for the material of the conductive leads does not itself jeopardize the stability of the assembly because of the inherently stronger mechanical bond provided by the solder connection.

Thus, the technical problem solved by the feature of the plurality of quantities of solder, each substantially covering one of the conductive leads within the meaning of claim 1, is to improve the mechanical resistance of the electronic package assembly to thermal stress, when provided with a solid encapsulant material.

- 5.5 Although mechanical rupture of electronic package assemblies under thermally induced stress undoubtedly constitutes a well known technical problem, the prior art on file does not in the Board's view disclose the claimed solution, nor even suggest that any benefit could be derived from a substantial covering of the



conductive leads with quantities of solder.

Document E4 in respect of thermal stress only points at the necessity of selecting materials having mutually compatible TCE values (see page 49 and the table on page 50). Specific indications as to quantities of solder can be found only in Figure 13.12 on page 193. Although referring to the assembly of leadless ceramic chip carriers (LCCC), which do not comprise any laterally projecting conductive leads, the figure shows in the foreground a connection which is specified as being unacceptable due to an excess of solder material. This is considered to support the appellant's argument that the skilled person generally avoids the use of excessive quantities of solder material for the connection of electronic packages to organic substrates.

The remaining documents on the file do not offer any teaching as to the proper quantity of solder to be employed when electrically connecting the conductive leads of an electronic package and the electrical conductors of an organic substrate.

For these reasons, the subject-matter of claim 1 is considered to involve an inventive step within the meaning of Article 56 EPC.

6. The same conclusion applies to the subject-matter of claim 12, which recites substantially the same limitations as claim 1 in terms of a method of making an electronic package assembly, and to claims 2 to 11 and 13 to 19 by virtue of their appendence to independent claims 1 and 12, respectively.

Accordingly, the grounds for opposition do not prejudice the maintenance of the patent unamended, in accordance with the appellant's request.

**Order**

**For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The patent is maintained unamended.

The Registrar:

The Chairman:

P. Martorana

E. Turrini