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Datasheet for the decision of 13 May 2025

Case Number: T 2586/22 - 3.4.03

Application Number: 11858254.3

Publication Number: 2674973

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Language of the proceedings: EN

Title of invention:
POWER SEMICONDUCTOR MODULE

Patent Proprietor:
Mitsubishi Electric Corporation

Opponent:
BOVARD LTD.

Relevant legal provisions:
EPC Art. 52(1), 54(1), 54(2), 56, 83, 100(a)

Keyword:
Novelty - claim 1 as granted, auxiliary requests 1 to 3 (no) - auxiliary request 4 (yes)
Inventive step - auxiliary request 4 (yes)
Sufficiency of disclosure - (yes)

Decisions cited:
T 1273/04

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Case Number: T 2586/22 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 13 May 2025

Appellant: (Opponent)	BOVARD LTD. Optingenstrasse 16 3013 Bern (CH)
Representative:	BOVARD AG Patent- und Markenanwälte Optingenstrasse 16 3013 Bern (CH)
Respondent: (Patent Proprietor)	Mitsubishi Electric Corporation 7-3 Marunouchi 2-Chome Chiyoda-ku Tokyo 100-8310 (JP)
Representative:	Hoffmann Eitle Patent- und Rechtsanwälte PartmbB Arabellastraße 30 81925 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 30 September 2022 rejecting the opposition filed against European patent No. 2674973 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	T. Häusser
Members:	M. Ley
	E. Mille

Summary of Facts and Submissions

I. The appeal of the opponent (appellant) is against the decision of the opposition division to reject the opposition against European patent EP 2 674 973 pursuant to Article 101(2) EPC.

II. The following documents will be referred to:

D1 JP 2004 006905 A and machine translation thereof
D3 JP H07 7112 A and machine translation thereof
D7 JP 3 160584 U and machine translation thereof
D9 JP 2001 144229 A and machine translation thereof

Certified translation of claim 1 of PCT application WO 2012/108011 A1 filed as annex to the statement setting out the grounds of appeal

HE1 Extract of the Oxford Advanced Learner's Dictionary, Fifth Edition, 1995, p. 390 and 391 filed by the respondent with its reply to the appeal

III. The appellant requests that the decision be set aside and the patent be revoked.

IV. The respondent (patent proprietor) requests that the appeal be dismissed.

Alternatively, it requests that the decision be set aside and the patent be maintained on the basis of one of auxiliary requests 1 to 16 filed with its reply to the statement setting out the grounds of appeal.

V. Claim 1 as granted has the following wording (board's feature labelling):

A power semiconductor module in which a semiconductor chip is sealed with resin, wherein said power semiconductor module comprises:
(a) *a plurality of electrode plates (2) in each of which* ***(a1)*** *an external connection terminal portion (2b) and* ***(a2)*** *a body portion (2a) are integrally formed, and* ***(a3)*** *the body portions (2a) are arranged on the same flat surface;*
(b) *a semiconductor chip (1) mounted on one surface (2c) of the body portions (2a) of said electrode plates (2); and*
(c) *a resin package (3) in which* **(c1)** *at least a part of the other surfaces (2d) of the body portions (2a) of said electrode plates (2) is exposed, and* **(c2)** *the body portions (2a) of said electrode plates (2) and said semiconductor chip (1) are sealed with resin characterized in that*
(d) *the exposed surfaces (2d) of the body portions (2a) of said electrode plates (2) form the same surface as the bottom (3a) of said resin package (3) on the exposed surface (2d) side except for an outer edge portion of the bottom (3a); and*
(d1) *the outer edge portion of the bottom (3a) of said resin package (3) is formed with a resin protrusion portion (6) continuously or intermittently, and* **(d2)** *base portions (2e) of the external connection terminal portions (2b), respectively, pass through the resin protrusion portion (6).*

Claim 1 according to auxiliary request 1 has the same wording as claim 1 as granted.

Respective claim 1 of auxiliary requests 2 and 3 has the wording of claim 1 as granted with the following additional feature (e) (of granted claim 2) after feature (d2):

(e) *wherein the width (W1) of the external connection terminal portion (2b) is narrower than the width (W2) of the body portion (2a) of said electrode plates (2).*

Claim 1 of auxiliary request 4 has the wording of claim 1 of auxiliary request 2 with the additional feature (f) (of granted claim 3) after feature (e):

(f) *wherein the body portion (2a) of said electrode plates (2) are formed with through holes (10), and the resin of said resin package (3) is also filled in the through holes (10), at least a part of the through holes (10) being formed at a portion where resin of the resin protrusion portion (6) is embedded.*

The wording of the claims of auxiliary requests 5 to 16 is not relevant for the present decision.

VI. The appellant argued that the subject-matter of claim 1 as granted and of auxiliary requests 1 to 3 lacked novelty over D1 and that the subject-matter of claim 1 of auxiliary request 4 lacked an inventive step over D1, D3 or D9 in combination with D7. Moreover, the appellant argued that the patent did not disclose the invention defined in dependent claim 2 of auxiliary request 4 in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

The respondent disagreed and argued that the subject-matter of claim 1 as granted was not known from D1 and

not rendered obvious by the prior art. The invention defined in dependent claim 2 of auxiliary request 4 was disclosed in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

Reasons for the Decision

1. The present invention relates to power semiconductor modules, in which a semiconductor chip is sealed with resin. They might be incorporated e.g. in a vehicular rotary electric machine. For this type of devices, heat generation is large and countermeasures concerning heat dissipation are required, see paragraph [0002] of the opposed patent.

As granted, the power semiconductor module has a plurality of electrode plates each of which having an external connection terminal portion and a body portion which are integrally formed, the body portions being arranged on the same flat surface. The power module also has a resin package in which at least a part of the surfaces of the body portions of said electrode plates is exposed. According to paragraph [0017] of the opposed patent, this allows a heat dissipation unit to be brought into contact with the exposed electrode plates, whereby heat dissipation properties and reliability are improved in comparison with the prior art arrangement described in paragraphs [0002] to [0006] of the opposed patent, in which heat emitted from the semiconductor chips also passes through the resin package which has a low thermal conductivity. This type of arrangement can be seen in Figures 1 to 12 of the opposed patent.

As further specified in granted claim 1, in the power semiconductor module, the outer edge portion of the bottom of the resin package is formed with a resin protrusion portion (continuously or intermittently), and base portions of the external connection terminal portions pass through the resin protrusion portion. According to paragraph [0037], in this way the electrode plates are prevented from peeling off the resin package. This type of arrangement is shown in Figures 5 to 10 and 12 of the opposed patent.

In claim 1 of auxiliary request 4, it is further specified that the body portion of the electrode plates are formed with through holes, and the resin of the resin package is also filled in the through holes, at least a part of the through holes being formed at a portion where resin of the resin protrusion portion is embedded. This arrangement is shown in Figure 10 of the opposed patent, see below.

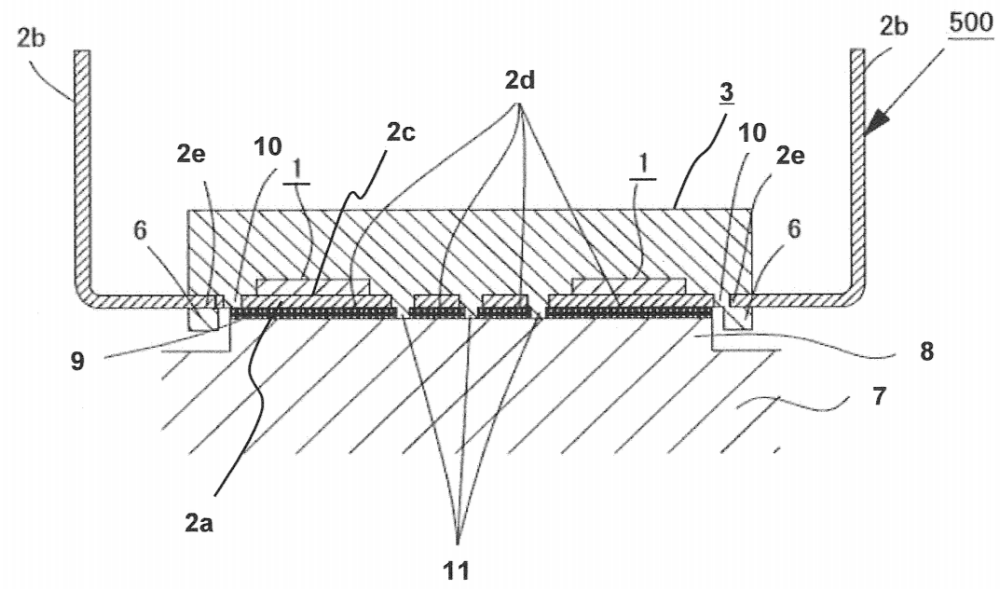


Figure 10 of the opposed patent

2. Respondent's main request, dismissal of the appeal

2.1 Claim construction - features (c), (c1) and (c2)

2.1.1 Features (c), (c1) and (c2) were interpreted by the opposition division as requiring that at least a part of the other surfaces of the body portions of the electrode plates were "exposed to the outside of the semiconductor module". As a consequence thereof, the opposition division concluded that D1 did not disclose the subject-matter of claim 1 as granted.

2.1.2 According to the appellant, features (c), (c1) and (c2) expressed the notion that it was the resin package that exposed (i.e. did not cover) "a part of the other surfaces of the body portions of said electrode plates", and not the semiconductor module as such. In other words, it was only required that said other surfaces were not covered by resin. They were exposed from the resin package. Feature (c1) thus did not require an "absolute exposure" as argued by the respondent, i.e. that the body portions were exposed to the outside of the power semiconductor module. This was confirmed by the translated wording of claim 1 of the Japanese PCT application and paragraphs [0027], [0028], [0032] of the patent. Contrary to the known packages (see paragraph [0005] of the opposed patent), heat did not pass through resin to be dissipated (e.g. to a heat sink). The appellant's understanding was thus in accordance with the problem described in paragraph [0005] of the opposed patent.

As the discussion of the correct interpretation had been present in the opposition proceedings, document HE1, which was submitted by the respondent with its reply to the grounds of appeal, should not be admitted

into the appeal proceedings.

The appellant noted that the wording of product claim 1 was open so that the presence of additional elements (e.g. of an "internal" or "external" heat sink) was not excluded, see also Figure 9 of the opposed patent. The application as a whole did not define what might be understood by an "external" heat sink.

Regarding Figure 9 of the opposed patent, the appellant argued that openings allegedly shown were not relevant for the invention. Paragraph [0039] of the opposed patent ("If [...] the resin protrusion portion 6 formed so as to surround the heat dissipation surfaces 2d is fitted to a convex portion 8 of the heat sink 7; and therefore, when the heat sink 7 is assembled, the heat sink 7 is not misaligned back and forth and around, and there is few concern that the heat sink 7 is misaligned due to vibration or the like during use") suggested that there was in fact no gap between the heat sink 7 and the resin protrusions 6.

The appellant also added that it was not allowed to use limitations derived from the description into the claims in order to avoid objections based on lack of novelty or inventive step (Case Law of the Boards of Appeal, 10th edition 2022, II.A.6.3.4). In the present case, the claim was clear in itself.

2.1.3 According to the respondent, the wording "exposed" had the common meaning, see paragraphs [0027], [0028], [0032] and document HE1, "something is made visible", "something is revealed".

The power semiconductor module had a resin package with a "region" which was revealed/visible. This implied an

"absolute exposure", as reflected by paragraph [0017] of the patent, "the surface (non-mounting surface) of an exposed electrode plate, on which the semiconductor chip is not mounted, is brought into contact with an external heat dissipation unit". The exposed region was not covered by resin and not by anything else, i.e. other components of the power semiconductor module. It was not merely "free from resin".

An external heat sink could be mounted on the exposed surface for heat dissipation, i.e. the heat dissipation surfaces of the electrode plates, as shown in Figure 9 of the opposed patent. Such an external heat sink did not form part of the claimed power semiconductor module. Even in the example of Figure 9, portions of the body portions between the resin protrusion 6 and the external heat sink 7 at the convex portion 8 were exposed. An "internal heat sink" as the one of Figure 24 of D1 was different.

This interpretation of claim 1 was not in disagreement with the translated claim 1 of the Japanese PCT application. In the translation submitted by the appellant, the translator chose to translate the Japanese verb for "to expose" using the active voice in such a way that the "resin package" formed the subject and "one part of the other face of the main body parts" formed the object of the sentence. This, however, was a deliberate choice by the translator appointed by the appellant and did not necessarily follow from the Japanese original text of claim 1 of the PCT application. In the Japanese original text, "resin package" and "one part of the other face of the main body parts" were not in a subject-object-relation. The Japanese word for "to expose" in the original text of claim 1 rather further explained the "resin package" by

defining the state in which "one part of the other face of the main body parts" was.

Hence, using the passive voice of the verb "to expose" as used in feature c1) "a resin package in which at least a part of the other surface of the body portions of said electrode plates is exposed" was a correct translation of the Japanese original text of claim 1 of the PCT application and was hence used in the European phase.

2.1.4 The board notes that the correct interpretation of features (c) to (c2) was a point of discussion during the opposition proceedings and in the impugned decision. The annex of the statement setting out the grounds of appeal with the certified translation of original Japanese claim 1 as well a dictionary extract HE1 were filed by the parties to support their respective views. Insofar, both submissions are admitted into the appeal proceedings.

The board agrees with the appellant that features (c) to (c2) imply that "at least a part of the other surfaces of the body portions of said electrode plates" is not covered by resin (i.e. is free of resin) so that in accordance with paragraph [0005] of the patent, heat does not pass through resin and is transferred to a heat sink. This uncovered part of the body portion (reference sign 2a in the figures of the opposed patent) forms a heat dissipation surface (see e.g. paragraphs [0022], [0027], [0028], [0036], [0037] of the opposed patent).

Hence, in accordance with the certified translation of claim 1 of the Japanese PCT application, document HE1, and the text of the specification, it is the resin

material of the resin package that reveals or makes visible a part of the body portions of the electrode plates as also shown in Figures 5 to 10 of the patent.

The open wording of claim 1 ("said power semiconductor module comprises") does not exclude other elements (such as a heat sink) attached to the exposed surfaces of the body portions oh the electrode plates.

The respondent's view that other elements (e.g. of the module) do not cover said "at least a part of the other surfaces of the body portions of said electrode plates" is not supported by the wording the claim or by the remaining parts of the opposed patent. For example, Figures 9 and 10 disclose examples according to granted claims with elements 7, 8, and 9 covering said exposed "at least a part of the other surfaces of the body portions of said electrode plates" for improved heat dissipation. In view of paragraph [0039] of the opposed patent, the board finds it at least questionable whether there is in fact an open space between the resin protrusions 6 and the heat sink 7 in Figures 9 and 10 of the opposed patent. As argued by the appellant, a skilled person would understand that said space has no technical relevance and it might be merely present in Figures 9 and 10 for reasons of illustration. There is no indication in the specification of the opposed patent that in the finished power semiconductor module (including a heat dissipation unit or a heat sink) parts of the body portions of the electrode plates would be exposed to the outside world.

In summary, it is not excluded that other elements (such as the heat sink 7 and the intermediate member 9 of Figures 9 and 10) cover the "at least a part of the

other surfaces of the body portions of said electrode plates", which is merely not covered by the resin or exposed from the resin package. This view is clearly in agreement with both the English text of granted claim 1 and the certified translation of the original Japanese claim 1, even though in both a different wording is used.

2.2 Claim construction - feature (b)

2.2.1 During the discussions in the context of the comparison of the claimed subject-matter with the disclosure of D1, D3 and D9, the respondent argued that the wording of feature (b) ("one surface of the body portions") implied that at least two of the body portions as defined by features (a), (a1) to (a3) have a chip mounted on their respective surfaces.

The term "one surface (2c) of the body portions" in feature (b) did not refer to a number of surfaces, but was used to distinguish between the side of the body portions on which the semiconductor chip was mounted and the side which was exposed. It thereby referred to the counterpart of the "other surfaces" in feature (c1), which was the exposed side of the body portions.

The wording of claim 1 encompassed one semiconductor chip having relatively large dimensions so as to be mounted on the surfaces of two body portions, which was an arrangement not disclosed in any of the embodiments shown in the Figures of the opposed patent. The wording of claim 1 also encompassed two chips mounted on the surfaces of two respective body portions as shown in Figures 1 to 12 of the opposed patent.

It followed that a power semiconductor module with one

single chip mounted on a same body portion (e.g. as the one possibly shown in Figure 24 of D1) was excluded.

2.2.2 The board does not share this view.

According to the features (a), (a1) to (a3), the claimed power semiconductor device comprises a plurality (i.e. at least two) of electrode plates with respective body portions "arranged on the same flat surface". As the electrode plates and their corresponding body portions are separate elements, the skilled person would understand that each body portion has its own surface (for mounting a semiconductor chip and/or for being covered with resin).
According to the explicit wording of claim 1, the power semiconductor device comprises (at least) one semiconductor chip which is mounted on one surface of the body portions. The board understands from the wording "one surface of the body portions" that the wording of claim 1 does not exclude that the one semiconductor chip is mounted on the surface of only one body portion. This is also shown in Figures 1 to 12 of the opposed patent.

The board also notes that all figures disclose electrode plates as defined by features (a) and (a1) to (a3) without any semiconductor chips mounted thereon. This is also not excluded by the wording of claim 1.

In other words, while the arrangements described by the respondent might be encompassed by the wording of claim 1, a power semiconductor module with one single chip mounted on one single body portion is not excluded.

2.3 Disclosure of document D1

2.3.1 Using their interpretation of the wording of features (c), (c1) and (c2), the respondent argued that in Figures 23 and 24 of D1 no parts of the body portions 106 were exposed to the outside of the power semiconductor module. One side of them was covered by resin 18, semiconductor chip 5, circuit boards 9, the other side being covered by adhesive 19 and metal base material 107 used for heat dissipation (see paragraph [0108] of D1). Element 107 was adhered to the metal element 106, 14a, 14b before providing the sealing resin 18, see paragraphs [0111] and [0113] of D1, so that it was a part of of the power semiconductor module and could be considered as an internal heat sink. Only element 107 was thus exposed from the resin package. The "internal" heat sink of D1 was different from the "external" heat sink shown in Figures 9 and 10 of the opposed patent.

Hence, for the respondent, the back surface of the lead frame 106 was in full-surface contact with the metal base material 107 via the adhesive 19 and all other surfaces of the lead frame 106 were covered by resin. No surface of the lead frame 106 was exposed. By lacking feature (c1), D1 also lacked features (d), (d1).

Moreover, Figure 24 of D1 disclosed only one semiconductor chip mounted on one body portion, contrary to what was required by the wording of feature (b). The term "mounted on" included a conductive adhesive or solder between the body portion and the semiconductor chip, but not a "electrically insulating control circuit body 9". In other words, electronic component 13 of Figure 24 was not a semiconductor chip

within the meaning of feature (b).

D1 at most disclosed only one electrode plate as claimed, and not a plurality thereof. In Figure 24 of D1 only one electrode plate had an external connection terminal portion 14a according to (a1) and integrally formed therewith a body portion 106 according to (a2). The external connection terminal portions 14b shown in Figure 24 did not have a body portion and the second body portion 106 did not have an external connection terminal portion. The respondent thus held that D1 lacked a plurality of body portions as defined by features (a), (a1) to (a3) and (b).

2.3.2 The appellant argued that the example of Figures 23 and 24 of D1 discloses all the features of claim 1 as granted: electrode plates (106, 14a, 14b), resin package (18), external connection terminal portions (parts of 14a, 14b outside the resin package 18), body portions (106, parts of 14a, 14b inside the the resin package 18), semiconductor chip (5). The module shown in Figures 23 and 24 further included electronic components 13 on a respective control circuit board body 9, see also Figure 28 of D1.

In view of its interpretation of claim 1, the body portions covered by adhesive layer 19 were not covered by the resin package 18 and were thus exposed within the meaning of feature (c1).

2.3.3 The board considers that the subject-matter of granted claim 1 lacks novelty (Article 52(1), 54(1) and (2) EPC) over D1.

Figures 23 and 24 concern the fourteenth embodiment of D1, which is described in paragraphs [0108] to [0115].

Document D1 discloses a power semiconductor module ([0108], Figure 24) in which a semiconductor chip (power semiconductor element 5) is sealed with resin (sealing resin 18), wherein said power semiconductor module comprises a plurality of electrode plates (lead frame 106, terminals 14a, 14b, [0109]) in each of which an external connection terminal portion (terminal 14b for delivering an input/output signal, terminal 14a for delivering a main current) and a body portion (lead frame 106) are integrally formed (metal, [0109]), and the body portions are arranged on the same flat surface (parts of lead frame 106 on heat conductive adhesive 19), see Figure 24 as modified by the appellant and reproduced on page 9 of the statement setting out the grounds of appeal, see below.

Figure 23 and 24 clearly show a plurality of lead frame parts 106 integrally formed with terminals 14a and 14b. The parts of terminals 14a and 14b passing through the resin 18 and extending to the outside are external connection terminal portions and the remaining parts (including element 106) are body portions. D1 thus discloses features (a), (a1) to (a3).

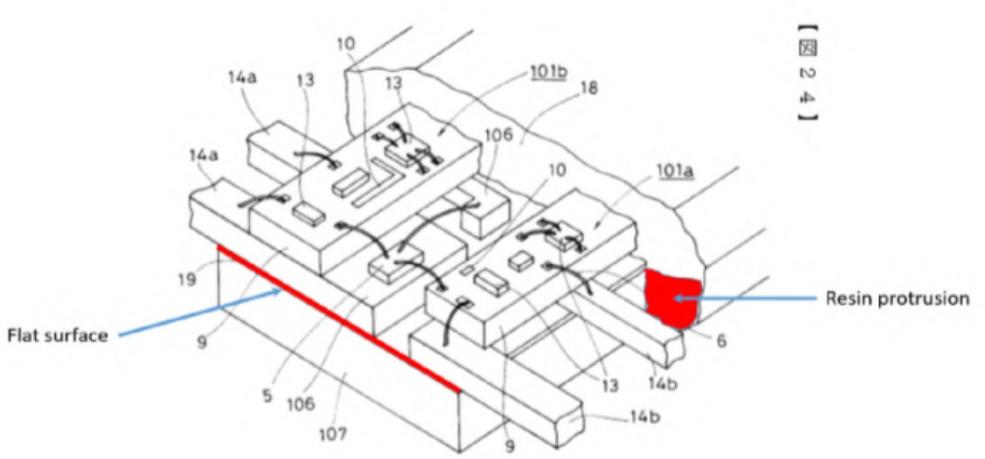


Figure 24 of D1 as modified by the appellant

In Figures 23 and 24, a semiconductor chip (power semiconductor element 5) is mounted on one surface (surface of the lead frame 106 opposite to the heat conductive adhesive 19) of the body portions (lead frame 106) of said electrode plates (106, 14a, 14b).

As pointed out in section 2.2.2 above, the board is of the view that this arrangement is encompassed by the wording of claim 1. D1 therefore discloses feature (b). The question whether electronic components 13 in Figure 24 are also semiconductor chips according to feature (b) can be left unanswered.

In Figures 23 and 24 of D1, a resin package (defined by the boundaries of sealing resin 18) in which at least a part of the other surfaces (parts of lead frame 106 covered with heat conductive adhesive 19) of the body portions (lead frame 106) of said electrode plates is exposed (Figure 24), and the body portions (lead frame 106) of said electrode plates (106, 14a, 14b) and said semiconductor chip (5) are sealed with resin (18).

The exposed surfaces of the body portions (lead frame 106) of said electrode plates (106, 14a, 14b) form the same surface as the bottom of said resin package (18) on the exposed surface side except for an outer edge portion of the bottom (Figure 24). The outer edge portion of the bottom of said resin package (18) is formed with a resin protrusion portion (Figure 24, see again the Figure 24 as modified by the appellant and reproduced in the statement setting out the grounds of appeal) continuously or intermittently, and base portions (14a, 14b) of the external connection terminal portions (14a, 14b), respectively, pass through the resin protrusion portion (Figure 24).

As pointed out by the appellant, the bottom surface of electrode 106 is not covered by resin material and is not embedded in the resin package. It is thus exposed from the resin package, as required by claim 1. The exposed surfaces contact the heat conductive adhesive 19 and dissipate heat to the metal base 107, which thus functions in the same way as heat sink 7 shown in Figures 9 and 10 of the patent. In view of the board's claim construction, see section 2.1.4, the presence of further elements (e.g. metal base 107 and/or heat conductive adhesive 19) is not excluded by the wording of claim 1. Hence, features (c), (c1), (c1) and (d), (d1), (d2) are disclosed in D1.

2.4 Insofar, the board concurs with the appellant that the subject-matter of claim 1 as granted is known from D1 so that the ground for opposition under Article 100(a) EPC in combination with Articles 52(1), 54(1) and (2) EPC prejudices the maintenance of the patent as granted.

Therefore the respondent's main request cannot be granted.

3. Admission of respondent's auxiliary requests 1 to 4

3.1 The appellant requested not to admit the auxiliary requests 1 to 4 into the appeal proceedings, because they did not represent a convergent development. Reference was made to T 1273/04. In the present case, auxiliary requests 1 to 4 (as well as lower-ranking auxiliary requests 5 to 10) were filed with the reply to the statement setting out the grounds of appeal and had already been presented during the opposition proceedings. However, they did "not follow a clear line because they [were] an erratic suite of claim

deletions, claim fusions or a combination of these two approaches, without any logical direction towards a single inventive concept. Rather, claim 1 as granted [was] being combined with more or less all dependent claims, alone or in combination between them, although subject-matter of dependent claims often [solved] a completely different problem and thus [represented] a completely different invention".

3.2 The respondent argued that auxiliary requests 1 to 4 (as well as the lower-ranking auxiliary requests 5 to 10) were no amendments within the meaning of Article 12(4) RPBA as they had been admissibly filed and maintained at first instance. In particular, they had been filed within the time limit according to Rule 116 EPC.

3.3 It is common ground between the parties that auxiliary requests 1 to 4 correspond to auxiliary requests 1 to 4 filed during the opposition proceedings as a reply to the opposition division's preliminary opinion. They are all directed to combinations of granted claims, which were discussed in the notice of opposition. In their provisional opinion, the opposition division stated that the opposition was likely to be rejected.

Therefore, auxiliary requests 1 to 4 were admissibly raised and maintained during the opposition proceedings so that they do not constitute an amendment within the meaning of Article 12(4) RPBA. They are thus part of the appeal proceedings.

4. Respondent's auxiliary request 1 to 3 - novelty

4.1 Auxiliary request 1

As the wording of claim 1 of auxiliary request 1 is identical to claim 1 as granted, its subject-matter lacks novelty (Articles 52(1), 54(1) and (2) EPC) over the disclosure of D1.

4.2 Auxiliary requests 2 and 3

4.2.1 The appellant argued that feature (e) was disclosed in Figure 24. Moreover, it referred to Figures 26 and 27 of D1, which were described in paragraph [0116]. A skilled person would understand that the electrodes of Figure 24 had the same layout as shown in Figures 26 and 27, only the thicknesses were different in both embodiments.

The appellant also argued that one might understand from the wording of feature (e) that only one electrode plate has a wider body portion. This was indisputably disclosed in Figure 24 of D1.

4.2.2 The respondent argued that Figure 24 of D1 disclosed only one electrode as defined by feature (e), namely the one having the semiconductor chip 5 mounted thereon. The other portion 106 did not have a corresponding external terminal portion. Figures 26 and 27 of D1 concerned a different embodiment.

4.2.3 In the board's view, it can be questioned whether the relationship between the width of the external connection terminal portion and the width of the body portion as defined by feature (e) has to be fulfilled for each and every electrode plate of the power semiconductor package. For the benefit of the respondent, the board accepts that it has to be met for

at least two electrode plates.

Figures 26 and 27 concern the sixteenth embodiment of D1, which seems to be related to the fifteenth embodiment shown in Figure 25, see paragraph [0124]. In the board's view, no information about the layout electrodes of Figures 23 and 24 can be directly derived therefrom.

However, the board notes that each lead frame portion 106 of Figure 24 has a part wider than the terminals 14a and 14b. Figure 23 discloses multiple lead frame portions 106 and their respective terminals 14a and 14b. Therefore, the skilled person would understand that the width of each lead frame portion (i.e. body portion) is larger than the width of their respective terminal (i.e. external connection terminal portion). Hence, D1 discloses feature (e) for a first body portion 106 having the semiconductor element 5 mounted thereon and a second body portion 106 having the wire from semiconductor chip 5 connected thereto. In accordance with Figures 23 and 24, the skilled person would understand that the terminal 14a of said second body portion 106 also extends through resin 18, but is only partially illustrated, because this terminal 14a is used to provide the "main current" (see [0109] of D1) to the semiconductor chip 5 (which is additionally connected through wires 6 to the control circuit boards 101a and 101b).

In other words, the board accepts the appellant's arguments that Figure 24 of D1 discloses two electrode plates in accordance with feature (e).

Hence, the subject-matter of claim 1 according to auxiliary requests 2 and 3 lacks novelty (Articles

52(1), 54(1) and (2) EPC) over the disclosure of D1.

5. Respondent's auxiliary request 4

5.1 The appellant argued that the subject-matter of claim 1 according to auxiliary request 4 was rendered obvious by a combination of D3, D9 or D1 with document D7 so that there was a lack of inventive step (Article 56 EPC).

No objections under Articles 52(1), 54(1) and (2) or Article 123(2) EPC were raised.

Moreover, the appellant argued that the invention defined by dependent claim 2 was not disclosed in a way sufficiently clear and complete for it to be carried out by a skilled person.

5.2 Inventive step over D3 in combination with D7

5.2.1 The respondent argued that three electrode plates were shown in Figure 3 of D3. Only one had a semiconductor chip mounted thereon and the other ones did not comprise a semiconductor chip, contrary to what was required by feature (b). D3 thus did not disclose features (a), (a1), (a2) and (b).

The board is not convinced by this argument. In view of section 2.2.2 above, claim 1 only requires one semiconductor chip mounted on a body portion. This is clearly disclosed in the figures of document D3.

5.2.2 D3 discloses (Figures 1, 2 and 4) a power semiconductor module in which a semiconductor chip ([0015], [0020], "semiconductor pellets 2", [0021], "power MISFET") is sealed with resin ([0020], "resin-sealed semiconductor

device", [0023], "resin encapsulant 1"), wherein said power semiconductor module comprises:
a plurality of electrode plates (inner leads 4, tab 3, outer leads 5, [0024] and [0025], Figures 2 and 3) in each of which an external connection terminal portion (part of inner leads 4, outer leads 5) and a body portion (tab 3, part of inner leads 4 with wires 7 connected thereto) are integrally ([0025], Figure 3) formed, and the body portions (tab 3, parts of inner leads 4) are arranged on the same flat surface (Figure 4);
a semiconductor chip (2) mounted on one surface (Figures 1, 3 and 4) of the body portions of said electrode plates (3, 4, 5); and
a resin package ("resin encapsulant 1") in which at least a part of the other surfaces (surfaces 4B, 3B) of the body portions (3, parts of 4) of said electrode plates (3, 4, 5) is exposed (i.e. free of resin), and the body portions (tab 3) of said electrode plates (3, 4, 5) and said semiconductor chip (2) are sealed with resin (1).

In D3, the exposed surfaces (3B, 4B) of the body portions (3, parts of 4) of said electrode plates (3, 4, 5) form the same surface as the bottom (3a) of said resin package (defined by resin 1) on the exposed surface side except for an outer edge portion of the bottom (Figure 4).

According to Figure 3 of D3, the width of the external connection terminal portion is narrower than the width of the body portion of said electrode plates.

Hence, D3 discloses features (a), (a1) to (a3), (b), (c), (c1), (d2), (d) and (e) and does not disclose resin protrusion portions as defined by features (d1)

and (d2) and fails to disclose feature (f).

5.2.3 According to the appellant, these distinguishing features had the technical effect of preventing the peeling off of the external connection terminals portion from the resin package due to vibration "in connection with driving and rotation" during the use of the power semiconductor module, see also paragraphs [0018] and [0037] of the patent. As the claimed subject-matter did not include a heat sink, the objective technical problem could not be an improved alignment of a heat sink, as alleged by the respondent.

For the appellant, the objective technical problem was thus to improve the prevention of the peeling off of the external connection terminal portion from the resin package. Although paragraph [0027] of D3 taught that protruding leads 6 sealed with the resin sealing body 1 helped preventing the lead from peeling off, this did not exclude to further improve the system.

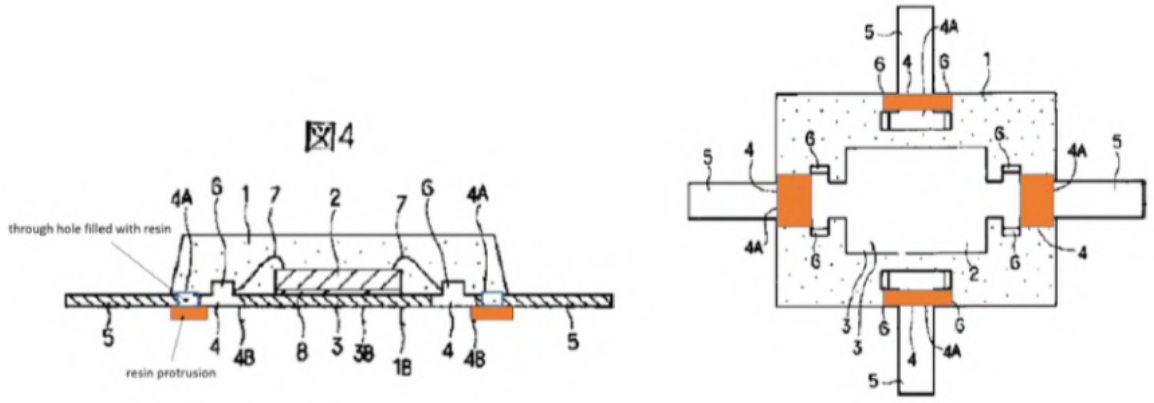
According to the appellant, the skilled person would consider document Document D7, which was related to a resin-encapsulated semiconductor module (paragraph [0001], abstract) and more particularly to the problem of adhesion strength between the lead-frame and the resin encapsulant (paragraphs [0009], [0011], [0027], [0032]). Figure 2 of D7 taught that for preventing the peeling off of a lead frame 1 of a power semiconductor module from resin sealing body 2, a through hole 3 should be provided near the peripheral portion of the lead frame 1 in order to improve the adhesion between the lead frame 1 and the resin sealing body 2. D7 also taught that due to the through hole 3 a resin convex portion 4 was formed so that the resin was "sandwiching" the lead frame.

Although the context in which the lead might peel off from the resin was different in D7 and D3 (manufacturing stress for an intermediate product versus stress during use of a final product), the problem remained the same and the solution of D7 was applicable.

When applying the teaching of D7 (see also [0017] and Figure 2 of D7) to the package of D3, the skilled person would provide the slits/through holes in the peripheral portion of the outer periphery, which was near the free ends of the lead frame, the lead frame (1) of D7 corresponding to the electrode plates (3, 4,5) of D3. Hence, according to D7, the resin protrusion should be formed in the peripheral region of the resin body, where shear stresses were at a maximum. The skilled person would not provide said slits at tab 3, contrary to the opposition division's and respondent's view, but at the inner lead 4, which were the parts of the resin package closest to the ends of the electrode plate. The skilled person would arrange the through holes and the resin protrusions at the outer edge of the package.

The appellant illustrated the position of the through holes in modified Figures 3 and 4 of D3 shown on page 17 of the statement setting out the grounds of appeal, see below.

In the appellant's view, the "base portion" of the external connection terminal according to feature (d2) was the segment of the electrode plate that was positioned at the "internal extremity" of the external connection terminal, said base portion being covered with resin, see Figures 2 and 3, paragraph [0022] of the patent.



Figures 3 and 4 of D3 as modified by the appellant (see page 17 of the statement of grounds of appeal)

By applying the teaching of D7 to the package of D3, the skilled person would provide through holes and resin protrusions at these positions with the external connection terminal portions "passing through the resin protrusion portion", while this meant, in view of the patent, that the base portion passed "underneath" the resin protrusion portions, as shown in Figure 6 of the opposed patent.

The appellant also argued that the skilled person would know how to adapt the mounting surface of any structure (e.g. circuit board, heat sink, etc.) that had the power semiconductor module to be positioned thereon, for example, by bending the leads as shown in Figure 1A and described in column 3, line 66 of D2. The mounting surface could also have cavities corresponding to the resin protrusions.

5.2.4 The respondent argued that, although the heat sink was not part a part of the subject-matter of claim 1, the resin protrusions enabled the module to have a configuration which allowed for improved alignment of

the external heat sink, see paragraph [0039] of the opposed patent. In other words, the resin protrusions rendered the module in an improved configuration as to alignment of an external heat sink. The technical problem to be solved should be formulated as how to improve the reliability of a power semiconductor module, see paragraph [0016] of the application underlying the patent.

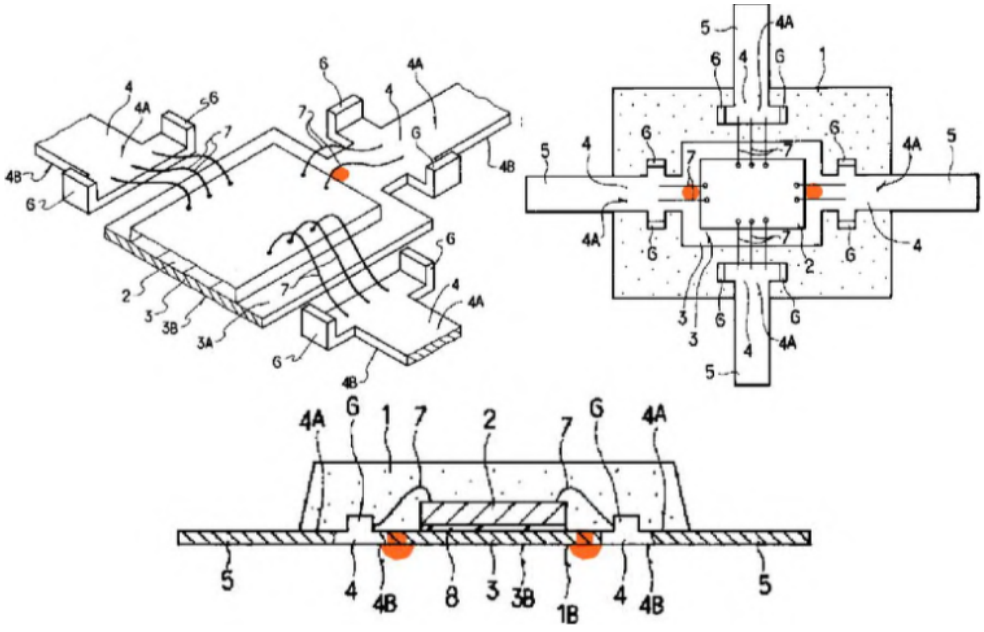
Even if avoiding peeling off of the external connection terminal portion from the resin package was the objective technical problem, an inventive step was to be acknowledged. For the respondent, this problem was solved in D3 by the protruding leads 6, see paragraphs [0027] and [0028]. The inner leads 4 were prevented from peeling off the resin sealing body 1. Wishing to further improve the prevention of peeling off, the skilled person might consider modifying these protruding leads 6.

With respect to D7, it disclosed a lead frame 1 without external connection portions and a resin encapsulant 2. D7 did not disclose a central die pad or any further details about the structure of the lead frame 2. Only a cut section of lead frame 1 was the final product in D7, parts A, D in Figure 2 of D7 becoming individual semiconductor devices, parts B and C being removed, see paragraph [0029]. Slits 3 were thus at locations that were cut, and not in external connection portions. The respondent agrees with the opposition division that the skilled person would consider tab 3 in D3 as corresponding to lead frame 1 (parts A, D) of D7. Paragraph [0027] of D7 dealt with peeling-off to be prevented during manufacturing, which was different from the peeling-off prevention when starting from D3.

The skilled person would thus not combine both documents.

D7 taught that the adhesion property between the resin sealing body and the lead frame was improved by simply pouring resin into through-holes, which were voids in the lead frame. The formed resin acted as an anchoring foot and was used for the lamination of semiconductor modules. However, the resin was not formed so as to cover the edge of the external lead terminal portion, like the resin protrusion portion of the present invention. There was no indication in D7 to provide the resin protrusions in the way shown in the modified figures of the appellant.

Hence, combining D3 with D7 would not lead to the claimed protrusions, only possibly to protrusions at the periphery of tab 3, as shown in the respondent's modified Figures on page 5 of its letter dated 22 November 2023. It would not arrive at protrusions as defined by feature (d2).



Figures 1, 3 and 4 of D3 as modified by the respondent

With respect to feature (d2), the respondent argued that according to Figure 5 of the opposed patent, the protrusion was not only above the external connection terminal portion 2b but also extended sideways. The protrusion 6 thus was wider than the external connection terminal portion 2b.

In addition, the respondent argued that the discrete semiconductor devices shown in D3 were mounted on an electronic circuit board on which an electronic circuit was formed, see paragraphs [0001], [0009], [0020] and [0029] of D3. A flush surface of the surface of the tab 3 on which the semiconductor chip 2 was mounted is needed, also for the heat transfer. Applying the teaching of D7 would deteriorate the ease of mounting.

5.2.5 For the board the claimed power semiconductor package does not include any heat sink and there is no indication in the wording of claim 1 that the resin protrusions are arranged in a way to allow a better alignment between the semiconductor chip and a heat sink. Hence, the distinguishing features do not solve a problem in relation with a heat sink. In this respect the board concurs with the appellant.

5.2.6 The distinguishing features provide the technical effect of preventing the peeling off of the external connection terminals portion from the resin package, see paragraph [0037] of the patent. Achieving this effect is to be considered as the objective technical problem.

5.2.7 Both documents D3 and D7 concern resin encapsulated packages. D7 deals with the adhesion between a resin sealing body 2 and electrode plates (lead frame 1), see paragraphs [0009], [0011], [0027], [0032]. This is

independent of the fact that the manufacturing in D7 might include method steps (such as the cutting step) that are not relevant in D3.

Hence, the board takes the view that the skilled person would consider document D7 when trying to solve the objective technical problem.

5.2.8 A lead frame, as the one used in D7, consists of a central die pad, where the die or chip is placed, surrounded by leads, i.e. metal conductors leading away from the die to the outside world. The end of each lead closest to the die ends in a bond pad. Small bond wires connect the die to each bond pad. This is explicitly described in D7, paragraph [0002] ("The lead frame is manufactured by forming a metal plate such as copper or copper alloy into a desired pattern by punching or etching with a precision press. A semiconductor element is mounted on the lead frame, and after wire bonding, resin sealing is performed"), paragraph [0003] ("In the lead frame 1, the resin sealing body 2 is molded on one main surface and nothing is molded on the other main surface. The other main surface is shown in a bottom view (b). The lead frame 1 is a metal plate such as copper or copper alloy, and is a matrix type lead frame in which individual semiconductor device patterns (not shown) are arranged in a plurality of rows and a plurality of columns along the length and width. Although not shown, a semiconductor element is mounted on each semiconductor device pattern, and the semiconductor element electrode terminals and the pattern internal terminals are connected by wires") and paragraph [0015] ("The lead frame 1 is a metal plate such as copper or a copper alloy as in the conventional case, and a matrix type lead in which individual semiconductor device patterns (not shown) are arranged

in a plurality of rows and a plurality of columns along the length and width. It is a frame. [...] Although not shown, a semiconductor element is mounted on each semiconductor device pattern, and the semiconductor element electrode terminals and the pattern internal terminals are connected by wires").

Hence, according to said paragraphs, it is clear for the skilled person that Figures 1 and 2 of D7 show the semiconductor device in a schematic way without the semiconductor chip and without any structural details of the lead frame 1.

Moreover, according to paragraph [0014], Figure 2 of D7 shows a SON QFP type resin sealing type semiconductor device. As pointed out by the respondent, individual devices are cut by a singulation device to complete the resin-sealed semiconductor device, see paragraph [0029], Figure 4, parts B and C as shown in Figure 4 being removed. Although not explicitly shown, the skilled person understands that the individual leads are cut in this singulation step so that a semiconductor package is obtained.

In other words, the tab 3 of document D3 does not correspond to the lead frame 1 of D7, but rather to the central die pad of said lead frame. Item 4 and 5 in D3 rather correspond to the lead of lead frame 1. In this respect, the board agrees with the appellant.

5.2.9 D7 teaches that the adhesion between resin material and a lead frame (including its central die pad and its leads) is enhanced by providing through holes 3 in the lead frame 1. From Figures 2 and 4 of D7, it follows that the through holes 3 are formed in the leads of lead frame 1 and not its central die portion. As

pointed out by the appellant, it seems that paragraph [0017] of D7 teaches to provide said through holes near the peripheral portion of the outer periphery of the lead frame in order to improve the adhesion between the lead frame 1 and the resin sealing body 2. According to Figure 2 of D7, the through holes are close to the edge of the resin sealing body.

Hence, attempting to solve the objective technical problem and applying the teaching of D7 to the device of D3, the skilled person could provide through holes in those parts of the electrode plates 3, 4 covered by the resin material 1 and close to the edge of resin material 1. The board takes the view that this would then to correspond to what is shown in the appellant's figures on page 16 of the statement setting out the grounds of appeal.

When providing the through holes at these positions, resin protrusions are formed, i.e. the outer edge portion of the bottom of said resin package would formed with a resin protrusion portion continuously or intermittently. As pointed out by the appellant, the wording of feature (d2) only implies that a part ("base portion") of the external connection terminal portions were positioned between said resin protrusions and the resin material, see Figures 6 to 10 of the patent. The board notes that the wording of claim 1 does not require any limitation with respect to the shape or dimensions of the resin protrusions. In other words, when applying the teaching of D7 to the device of D3, base portions of the external connection terminal portions (parts of 4, 5), respectively, would pass through the resin protrusion portion.

While the board agrees that the skilled person could apply the teaching of D7 in the power semiconductor package of D3 and possibly arrive at the claimed subject-matter, the skilled person would not provide such resin protrusions in the module of D3. The board accepts the respondent's arguments that the skilled person would understand from D3 that a flat bottom surface is necessary for an efficient heat dissipation and for mounting the module e.g. on a circuit board. The appellant's argument that by bending the terminal electrode and creating a cavity or cavities below the tab 3 of D3 and said circuit board would even improve heat dissipation is mere speculation. Neither D3 nor D7 suggest how to adapt the mounting surface to resin protrusions, as in D7 the protrusion are cut away and not present in the final device.

In other words, in order to solve the objective technical problem in D3, the skilled person would not use the claimed solution, but possibly consider other ways to avoid the peeling off the leads 4, 5 in D3, e.g. by modifying the items 6, as argued by the respondent.

Hence, the skilled person would not modify the device of D3 so as to include features (d1) and (d2) in an obvious way.

5.3 Inventive step over D9 in combination with D7

5.3.1 The appellant pointed out in section VI. of the statement setting out the grounds of appeal that document D9 (Figures 3 and 4) disclosed a power semiconductor module with features (a) to (d). Figure 4 also showed feature (e), because the electrode plates 3, 4 and 5 had a wider body portion within resin 9 and

a narrower extending external connection terminal portion outside the resin 9, semiconductor element 6 being a semiconductor chip.

D9 did not disclose features (d1), (d2) and (f). For the reasons given with respect to D3, said distinguishing features were obvious in view of D7. The skilled person would provide through holes near the peripheral portion of the outer periphery of the electrode plate (5, 2) and arrive at the claimed resin protrusions. The appellant did not agree that the bottom surface of the module of D9 had to be flat.

5.3.2 The respondent argued that projections 4 in D7 ensured that neighbouring power modules were separated from each other. This was not an issue in D9. Moreover, the skilled person would regard central part 2 of D9 as corresponding to parts A, D of D7 and not provide resin protrusions at the claimed locations. The respondent also argued that D9 required a flat bottom surface to mount the module e.g. on a circuit board.

5.3.3 The board agrees with the appellant that features (a) to (d) and (e) are known from D9. In particular, Figures 1 and 4 clearly disclose wider parts and narrower parts of electrode plates 3, 4 and 5. As pointed out already, the wording of claim 1 only requires one semiconductor chip (element 6 in D9).

The objective technical problem of distinguishing features (d1), (d2) and (f) is the prevention of peeling of the external connection terminal portions from the resin 9. The skilled person would understand that through holes in D7 are not to be provided in the central die pad of the lead frame 1 of D7 and might consider to provide such through holes in the leads 3,

4, 5 of D9.

However, as for document D3, the board accepts the respondent's argument that the skilled person would not deviate from the flat bottom surface of the semiconductor power module of D9 in order not to deteriorate heat dissipation.

5.4 Inventive step over D1 in combination with D7

5.4.1 The appellant argued that D1 did not disclose feature (f). The technical effect would be an improved adherence between the electrode plate and the resin package, see paragraph [0031] of the opposed patent, and to simplify the manufacturing process thereof. This would be obvious in view of D7 that discloses through holes in the electrode plates, for the reasons given in the context of D3. D7 also taught in paragraph [0005] that it was known to provide through holes in lead frames to achieve an improved anchoring.

5.4.2 The respondent argued that the electrode plates are glued to the element 107 by adhesive 19. There was not a problem of insufficient adherence. The skilled person would not consider the through-holes of D7 as they were merely used in the intermediate product during manufacturing, but not in the final end product. The leads 14a and 14b were fully surrounded by resin material so that there was no need for any through hole.

5.4.3 First, the board is of the view that providing through holes in body portions of D1 would not simplify the manufacturing, contrary to what the appellant argued, because additional manufacturing steps are required.

The objective technical problem might be seen as improving the adherence between the resin and the lead frame.

The board is of the view that the skilled person would not be motivated by document D7 to provide through holes in the metal parts 106, 14a or 14b of D1.

As pointed out by both parties, D7 teaches to provide through holes in a lead frame so that after the encapsulation, resin is on both sides of the lead frame as shown in the figures of D7. Paragraph [0005] also discloses a "resin lock hole" in a lead frame without any indication where it should be positioned.

In D1, however, for the fourteenth embodiment shown in Figures 23 and 24, metal substrate 107 is fixed to the the lead frame 106 using adhesive 19. Only then the resin encapsulation is provided. The skilled person would thus not apply the teaching of document D7 to the parts of the electrodes plates covered by the metal substrate 107, because it is not possible to have resin on both sides thereof.

The board finds it questionable to provide through holes in the external connection terminal portions 14a, 14b, because they are already fully encapsulated by the resin 18, see Figures 23 and 24. Even if the skilled person would do this, these through holes would not be positioned at the claimed locations, because they would not be in a body portion as required by feature (f).

5.5 As the claimed subject-matter is not rendered obvious by the prior art at hand (D1, D3, D7 and D9), an inventive step (Articles 52(1) and 56 EPC) is to be

acknowledged.

5.6 Sufficiency of the disclosure

5.6.1 The appellant argued that a claw according to granted claim 4 or claim 2 of auxiliary request 4 was disclosed in embodiment 3 shown in Figure 11, which was not part of the invention, see paragraph [0020] of the patent. There was no embodiment describing the invention according to granted claim 4. The skilled person would understand that the claw shown in Figure 11 was not a claw according to the invention. It would be misled and not be able to carry out the invention according to granted claim 4.

5.6.2 For the respondent, the skilled person would understand the term "claw" from Figure 11 and paragraph [0046], even if said Figure did not concern an embodiment according to the invention, because it lacked resin protrusions. In Figure 11, claw 2f was a part of the body portion of the electrode plate bent on the mounting surface side 2c. The advantage was that electrode plate 2 was biting into resin package 3 and contact properties could be improved. Such claw was not incompatible with the resin protrusion 6 shown in Figure 5. Hence, the skilled person had sufficient information to carry out the invention.

5.6.3 The board first notes that it is undisputed that the embodiment 3 shown in Figure 11 and described in paragraphs [0045] to [0048] is not an embodiment according to the invention as claimed by granted claim 1, because no resin protrusions are present. This is also the case for the "embodiment 1" shown in Figures 1 to 4 and described in paragraphs [0021] to [0034], see paragraph [0020] of the patent, or the examples shown

in Figures 5 to 9 and 12 (lacking any through holes), although paragraph [0019] states that all these examples are "embodiments of the present invention".

The skilled person would understand that a claw is a portion of the body portion that is bent. One example of a claw is shown in Figure 11. However, the wording of claim 2 of auxiliary request 4 is clearly not limited to the claw shown in Figure 11. For example, the wording of claim 2 does not specify the contact between said claw and the resin material.

In summary, the board is of the view that the opposed patent describes the invention defined by dependent claim 2 of auxiliary request 4 in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art (Article 83 EPC).

6. As the claims of auxiliary request 4 meet the requirements of the EPC, the opposed patent is to be maintained based thereon.

As the description does not yet reflect that only the example shown in Figure 10 is an embodiment of the invention as defined in claim 1 (see e.g. section 5.6.3 above, first paragraph), the description is to be adapted.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division with the order to maintain the patent with the following claims and drawing sheets and a description to be adapted thereto:

   Claims: n° 1 to 4 of auxiliary request 4 filed with the letter dated 5 June 2023;

   Drawings: sheets 1/12 to 12/12 filed with the entry into the regional phase before the EPO.

The Registrar: The Chairman:

S. Sánchez Chiquero T. Häusser

Decision electronically authenticated