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**Datasheet for the decision  
of 10 August 2020**

**Case Number:** T 2232/16 - 3.4.03

**Application Number:** 09790134.2

**Publication Number:** 2313924

**IPC:** H01L25/07, H01L23/373

**Language of the proceedings:** EN

**Title of invention:**  
GROUNDING SYSTEM AND APPARATUS

**Applicant:**  
Johnson Controls Technology Company

**Headword:**

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

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

**Decisions cited:**  
T 1658/12

**Catchword:**



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Case Number: T 2232/16 - 3.4.03

**D E C I S I O N**  
**of Technical Board of Appeal 3.4.03**  
**of 10 August 2020**

**Appellant:** Johnson Controls Technology Company  
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**Decision under appeal:** **Decision of the Examining Division of the  
European Patent Office posted on 3 May 2016  
refusing European patent application No.  
09790134.2 pursuant to Article 97(2) EPC.**

**Composition of the Board:**

**Chairman** G. Eliasson  
**Members:** M. Papastefanou  
W. Van der Eijk

## Summary of Facts and Submissions

- I. The appeal is against the decision of the examining division refusing the European patent application No. 09 790 134.2 (published as WO 2010/008974 A1) on the grounds that the sole request before it did not involve an inventive step (Article 56 EPC).
- II. The appellant (applicant) requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims of a request composed by the following application documents (see paragraph bridging pages 2 and 3 of appellant's letter of 20 May 2020):
- Description, pages 1 to 8 filed with letter of 20 May 2020;
  - Claims 1 to 9 filed as Auxiliary Request with letter of 20 May 2020;
  - Drawings, Sheets 1/6 to 6/6 as originally filed.
- III. Reference is made to the following documents:
- D1:** Zhenxian Liang et al., *"Functional Integration in Active IPEM by Using a Planar Integration Technology"*, Applied Power Electronics Conference and Exposition, vol. 1, 6 March 2005, pages 375-381;
- D2:** US 2002/162673 A1
- D5:** EP 0 734 198 A2
- D6:** JP 2007 181351 A.
- IV. Claim 1 is worded as follows:
- A power semiconductor apparatus comprising:*
- *a semiconductor module (40) comprising a base (104), a semiconductor device (112), a grounding*

*assembly and associated control circuitry mounted on the base (104);*

- *a nonconductive heat sink (42) in thermal communication with the base (104) and in fluid communication with a source of liquid, wherein the nonconductive heat sink (42) is composed of ceramic or rubber; and*
  - *the grounding assembly comprising:*
    - *a first conductive layer (102), a second conductive layer (103); and a substrate (110) disposed between the first conductive layer (102) and the second conductive layer (103), wherein the second conductive layer (103) is attached to the base (104), the base (104) being connectable to earth ground (108);*
    - *the first conductive layer (102) in electrical contact with the semiconductor device (112) and the substrate (110) being electrically insulated from the second conductive layer (103) by the substrate (110);*
    - *the second conductive layer (103) in electrical contact with the substrate (110) and disposed between the substrate (110) and the base (104);*
- wherein the first conductive layer (102), the substrate (110) and the second conductive layer (103) form a capacitance path between the semiconductor device (112) and the base (104) for reducing circulating currents.*

V. The appellant argued essentially that the examining division erred in its interpretation of the disclosure of D6 and that there were more features distinguishing claim 1 from D6 than those considered by the examining division. Moreover, the skilled person starting from D6 as closest prior art would never consider D5 and even if they did, a combination of D6 with D5 would not lead to the claimed invention.

## **Reasons for the Decision**

1. The appeal is admissible.
2. The claimed invention
  - 2.1 The claimed invention relates to grounding systems for semiconductor power apparatus with a non-conductive heat sink.
  - 2.2 The claimed apparatus comprises a semiconductor module containing a semiconductor device. The semiconductor device is mounted on a base. There is a conductive layer (upper/first conductive layer) between the base and the semiconductor device. An insulating substrate (e. g. ceramic) is placed between the first conductive layer and the base (see paragraph [0008] of the application as published).
  - 2.3 One problem occurring in such structures is the presence of parasitic capacitances between semiconductor devices or the first conductive layer and the base. Further problems are caused by the use of non-conductive heat sinks. When the semiconductor module (including base, substrate and conductive layer) is mounted on a heat sink made of non-conductive material, parasitic currents and electrical charges build up between the base of the semiconductor module and the current conductors of the module, which may interfere with control signals of the semiconductor module and affect the operation of the semiconductor device (see paragraphs [0004], [0005] and [0030] of the application as published).

2.4 The claimed invention addresses these problems by providing a grounding assembly in the semiconductor module. A second (lower) conductive layer is provided between the insulating substrate and the base, so that the substrate is located between the two conductive layers. The second conductive layer is electrically connected to the base and the base is electrically connected to the ground (or other reference potential).

2.5 This structure introduces a capacitance that couples the semiconductor device's internal conductors and other conductors of the module to the grounded base. This prevents electrical charges from accumulating between the base and the conductive parts of the semiconductor module as well as among the conductive parts of the semiconductor module themselves and reduces significantly the parasitic currents (see paragraph [0031] and Figure 8).

### 3. Inventive Step (Article 56 EPC)

Claim 1 of the current request corresponds to claim 1 underlying the decision under appeal; only the order of the features has been modified.

#### 3.1 Closest prior art

3.1.1 Document D6 (JP 2007 181351 A) was used in the impugned decision as closest prior art.

The examining division sent an automatic English translation of D6 to the appellant (then applicant) with the annex to the summons to oral proceedings (issued on 19 November 2015). In the statement of the grounds of appeal, the appellant pointed out that the translation sent by the examining division and used as

reference in the decision under appeal was not the translation of D6 but of the corresponding Japanese patent, which was published after the priority date of the application (see statement of the grounds of appeal, point 1). The appellant submitted a copy of an automated English translation of D6 with the statement of the grounds of appeal.

The board took note of the appellant's observation but did not consider that the automatic English translation of the patent differed in such a way from the translation of the patent application provided by the appellant that the arguments of the examining division were to be disregarded. In the following, the board will refer to the translation provided by the appellant as D6a.

- 3.1.2 Document D6 discloses a poser semiconductor apparatus with a semiconductor module with semiconductor devices 5, 6 mounted on a grounding assembly (Figures 1 and 2). The grounding assembly comprises a first conductive layer 3,4 formed on one side of a ceramic substrate 2 and in electrical contact with the semiconductor devices. A grounded, second conductive layer 1 is formed on the other side of the ceramic substrate. The second conductive layer 1 mounted on a conductive heat sink 28 (cf. Figures 1, 2 and 13, paragraph 22).

It remains uncontested that D6 discloses all the features of claim 1 except the base and the non-conductive heat sink composed of ceramic or rubber and in the thermal communication with the base and in fluid communication with a source of liquid.

- 3.1.3 Regarding the base, the examining division considered the heat sink (28) of D6, which was conductive and



grounded (see Figure 13 as well as paragraphs [0003] and [0007] of D6a), to correspond to the base of the claim (see points 2.2.1 and 2.2.2 of the impugned decision).

The appellant counter-argued that in the claimed apparatus the base (104) was part of the semiconductor module (40), whereas in D6 the heat sink was separate from the module, as D6 repeatedly mentioned that the (inverter) module was installed/mounted on the heat sink (28) (see for example paragraphs [0003], [0004] and [0007] of D6a, as well as the first two paragraphs on page 4 of the statement of the grounds of appeal).

3.1.4 For the sake of the assessment of inventive step the board takes the view of the examining division because it is the least favourable for the appellant. Hence, the heat sink (28) of D6 is considered to correspond to the base of the claim.

3.2 Difference and technical problem

3.2.1 The apparatus of claim 1 differs, thus, from D6 in that it comprises a *nonconductive [sic] heat sink in thermal communication with the base and in fluid communication with a source of liquid, wherein the nonconductive [sic] heat sink is composed of ceramic or rubber.*

3.2.2 The technical effect of this distinguishing feature is that it provides for an improved cooling of the semiconductor module of the claimed apparatus.

The skilled person is faced, thus, with the technical problem of how to improve the heat dissipation capacity of the apparatus of D6 (in line with the examining division's reasoning, see point 2.2.3 of the impugned

decision).

### 3.3 Solution and obviousness

3.3.1 In the decision under appeal, the examining division was of the opinion that the skilled person would combine D6 with D5 and reach the claimed invention in an obvious manner (see point 2.2.5 of the decision).

D5 describes a cooling device for electronic components, in particular for an inverter used in a washing machine (see abstract). The components of the inverter are mounted on a base plate (Grundplatte 22). The inverter is placed in a housing (Gehäuse 10) made of plastic (Kunststoff) in such a way that the base divides the housing in two parts. In one part the inverter is placed. The other part is connected to the water supply of the washing machine. Fresh water flows through this part into the drum of the washing machine under the control of a magnetic valve (see column 2, line 54 to column 3, line 59 and the Figure of D5).

3.3.2 The board does not share the opinion of the examining division regarding the interpretation of D5. In the board's view the part of the housing that is filled with water (Kammer 28) cannot be interpreted as a heat sink in the sense of the claims. In D5 it is the water that plays the role of the heat sink, since it is the water that is in thermal communication with the base plate (Grundplatte 22) of the inverter and dissipates the heat. The plastic housing (Gehäuse 10) is not in thermal communication with the base plate as it merely serves as support for the base at its edges. In addition, water is conductive.

In the board's view a combination of D5 with D6 would

lead the skilled person to add a plastic water container in the back side (opposite side from the one the semiconductor module is mounted on) of the heat sink (28) of the apparatus of D6. The heat sink (28) would thus be in the position of the base plate (Grundplatte 22) of the apparatus of D5.

3.3.3 This combination would not lead to the claimed apparatus, since there would still be no non-conductive heat sink in thermal communication with the base in the apparatus obtained by the combination of D6 with D5.

3.3.4 A combination of D6 with D2 would not lead to the claimed invention, either.

D2 describes a semiconductor apparatus comprising a semiconductor module without the grounding assembly of claim 1 but with a base plate (backplate 32) and a heat sink (assembly 20) that is in thermal communication with the base plate and in fluid communication with a source of fluid (see paragraphs [0036] and [0037] and Figure 1 of D2).

The heat sink is made of a doped synthetic polymer (see paragraph [0036]). Hence, although a synthetic polymer would anticipate the rubber of claim 1, the fact that the synthetic polymer is doped (with e. g. nickel, carbon fibre, aluminum) makes the heat sink conductive in contrast to the heat sink of the claimed apparatus.

The board notes that in claim 1 of D2 a synthetic polymer material for packaging liquid cooling assemblies without doping is claimed.

However, the board is of the opinion that such an embodiment is not supported by the content of D2 as a

whole and cannot be considered as part of its disclosure. It is repeatedly mentioned in D2 that the aim of the described device was to provide a packaging for electronic materials (components) which, among others, provides effective electromagnetic interference (EMI) shielding (see for example paragraphs [0022] to [0028], [0034] and [0035]). It is apparent, that in order to provide effective EMI shielding, the packaging has to be made of a conductive material. Indeed, there is no embodiment or example in D2 where there is mention or suggestion of non-conductive materials used for the packaging (and the cooling assembly).

In the board's view, therefore, the skilled person would directly and unambiguously derive from the content of D2 as a whole that only assemblies made of conductive materials are contemplated (see also T 1658/12, Catchword and points 3.8 to 3.10 of the reasons).

A possible combination of D6 with D2 would, thus, not lead to the claimed apparatus, since the non-conductive heat sink would still be missing and neither D6 nor D2 gives a hint to the skilled person to contemplate a heat sink made of non-conductive material in an obvious manner.

- 3.3.5 As for document D1, it discloses a semiconductor apparatus similar to the one of D6, with a semiconductor module comprising an insulated (ceramic) substrate between two conductive layers, which is mounted on a conductive, grounded heat sink (see page 378, section D and Figure 5c). D1 would not provide any further hints to the skilled person on how to reach the claimed apparatus in an obvious manner, either.

- 3.4 The board concludes, thus, that the subject-matter of claim 1 involves an inventive step within the meaning of Article 56 EPC. Claims 2 to 9 depend directly or indirectly on claim 1 and are also inventive.
4. The description has been adapted to the claims and the prior art documents D5 and D6 are cited therein (see page 2). The requirements of Article 84 EPC and Rule 42 EPC are thus met.
5. The board is therefore satisfied that the application and the invention to which it relates meet the requirements of the EPC and, hence, a European patent is to be granted according to Article 97(1) EPC.

## Order

### For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the examining division with the order to grant a patent in the following version:
  - Description, pages 1 to 8 filed with letter of 20 May 2020;
  - Claims 1 to 9 filed as Auxiliary Request with letter of 20 May 2020;
  - Drawings, Sheets 1/6 to 6/6 as originally filed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

G. Eliasson

Decision electronically authenticated