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**Datasheet for the decision
of 31 October 2013**

Case Number: T 2087/08 - 3.4.01

Application Number: 00107262.8

Publication Number: 1043591

IPC: G01R1/20, H01L23/62, H01L23/64

Language of the proceedings: EN

Title of invention:
Power semiconductor module

Patent Proprietor:
MITSUBISHI DENKI KABUSHIKI KAISHA

Opponent:
Infineon Technologies AG

Headword:
Combination of features (synergy - no)
Inventive step (yes)

Relevant legal provisions:
EPC 1973 Art. 56, 100(a)

Keyword:

Decisions cited:

Catchword:



**Beschwerdekammern
Boards of Appeal
Chambres de recours**

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Case Number: T 2087/08 - 3.4.01

D E C I S I O N
of Technical Board of Appeal 3.4.01
of 31 October 2013

Appellant: Infineon Technologies AG
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Decision under appeal: **Decision of the Opposition Division of the
European Patent Office posted on 27 August 2008
rejecting the opposition filed against European
patent No. 1043591 pursuant to Article 101(2)
EPC.**

Composition of the Board:

Chairman: G. Assi
Members: P. Fontenay
C. Schmidt

Summary of Facts and Submissions

- I. The appeal lies from the decision of the opposition division to reject the opposition against European patent No. 1 043 591. The decision was dispatched on 27 August 2008.
- II. The opposition was only based on the ground of lack of inventive step (Articles 100(a) and 56 EPC 1973). In the "Reasons for the Decision", the opposition division considered that document EP-A-0 680 147 (D3) illustrated the closest prior art. Starting from this prior art and considering the disclosure of the other documents cited in the notice of opposition, the subject-matter of claim 1 of the patent as granted was not considered obvious. Concretely, the opposition division held that documents US-A-4 001 684 (D2) and DE-A-36 11 595 (D4), on which the opponent had more particularly relied, did not relate to relevant subject-matter, since neither of these two documents related to the field of power semiconductor modules and, in this context, to high-frequency current detection.
- III. The appellant (opponent) filed an appeal against said decision by letter dated 24 October 2008 and paid the prescribed appeal fee on the same day.

The appellant requested that the impugned decision be set aside and the patent be revoked in its entirety.

- IV. In the ensuing written statement setting out the grounds of appeal dated 15 December 2008, the appellant reiterated its view that the subject-matter of claims 1 to 5 of the patent as granted was not inventive. Particular reference was made in this respect to two

new filed documents DE-C-40 30 797 (D6) and US-A-1 100 708 (D7) considered to be relevant for the issue of inventive step.

Documents D6 and D7 pertained to the technical field of the invention and addressed the same general problem as the invention, namely to improve the accuracy of current measurements in high-frequency environments. This general problem implied de facto solving two partial problems consisting in the need, first, to minimize the inductance in the current sensor and, second, to compensate for the effects of the rest inductance in said sensor which affected the current measurements. In the appellant's view, it would have been obvious to modify the power semiconductor module of D3 in the light of documents D6 and D7 and thus to arrive at the subject-matter of claim 1 of the patent as granted. This analysis, which was reiterated and further developed in a letter of 31 July 2009, justified the combination of three documents in an objection under Article 56 EPC 1973.

- V. In a letter of reply dated 24 April 2009, the respondent (patentee) contested this approach. In its view, the features of the characterising portion of claim 1 should not be dealt with independently because they combined in order to allow an improved measurement of the current flow.

The respondent requested that the patent be maintained unamended.

- VI. Both parties requested oral proceedings as auxiliary requests.

VII. On 14 August 2013, the Board issued a communication pursuant to Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA), expressing its provisional opinion with regard to the parties' requests then on file.

In the Board's provisional opinion, the features recited in the characterising portion of claim 1 of the patent as granted relied, basically, on two different measures (reduction of the inductance in a first current sensor and compensation of the residual inductance by means of a second current sensor so as to carry out differential measurements), which both contributed to improving the overall accuracy of current measurements. The association of these two measures in one and the same module did not appear to have an effect extending beyond the sum of the partial effects to be expected from each of said measures when considered in isolation. The circumstance that each of said measures contributes to a common purpose, namely to minimize the adverse effects of inductance in current measurements, did not affect this provisional finding.

VIII. The respondent reacted to the communication of the Board by a letter dated 30 September 2013 requesting as a main request that "*the Appeal be set aside [sic!] and the patent maintained on the basis of claims 1-5 as granted...*". As an alternative, maintenance of the patent on the basis of various sets of claims according to first, second, or third auxiliary requests, annexed to the letter of reply, was requested.

IX. Oral proceedings before the Board took place on 31 October 2013, both parties being represented.

- X. During the oral proceedings the parties confirmed their respective requests previously made in writing.

In particular, the appellant requested that the decision under appeal be set aside and that the patent be revoked in its entirety.

The respondent requested that the appeal be dismissed as a main request or that the patent be maintained in amended form on the basis of sets of claims according to a first auxiliary request or a second auxiliary request or a third auxiliary request, as filed by letter of 30 September 2013.

- XI. The appellant referred for the essential to the submissions made in writing, further emphasizing that the principles underlying the disclosure of documents D6 and D7 (carrying out a differential measurement and selecting U-shaped sensors, respectively), were actually part of common general knowledge. For these reasons, the incorporation of sensors of a U-shaped type in a differential current sensor in order to eliminate or at least minimize the known adverse affects of inductance resulted from the exercise of normal practise when applied to the power semiconductor module of D3.

The respondent contested this analysis. In its view, the claimed configuration did not only permit to eliminate the effects resulting from self inductance but also the effects of mutual inductances resulting from external magnetic fields. This aspect was fundamental in view of the high currents flowing in the neighbourhood of the currents sensors and the fact that each sensor was affected differently depending on its actual location with regard to the sources of external

magnetic fields. Moreover, the incorporation of U-shaped current sensors in a differential measuring configuration permitted to reduce the amount of errors resulting from constructional tolerances in the manufacturing of the individual current sensors. In the respondent's opinion, all these effects provided evidence of the synergy which resulted from the claimed combination of features.

The respondent further objected to the fact that the analysis developed by the appellant relied on general knowledge that was not supported by any evidence. Moreover, even if the skilled person envisaged modifying the system of D3 by incorporating the teaching of D6 and D7, the resulting power module would not reproduce the claimed configuration. In this respect, there was no mention in D6 of a primary current being *"detected from a difference between potential differences at inner portions of the respective current sensors"*.

XII. Claim 1 of the respondent's main request reads:

"1. A power semiconductor module comprising an insulating substrate (2), a plurality of semiconductor devices (3, 4) provided on the insulating substrate, a plurality of module electrodes (27) provided on the insulating substrate and connected to the semiconductor devices, a current sensing unit (28), and the current sensing unit comprising a first current sensor, wherein the current sensor includes a conductor provided in a primary current path characterized in that the conductor includes parallel flat plates (28a, 28c) so as to have a substantially U-character shape in section, wherein a primary current is detected from a

potential difference between inner portions (34, 35) of the conductor, and

the current sensing unit includes a second current sensor connected in series and the two current sensors (75, 76) have equal inductance and different resistance, wherein the primary current is detected from a difference between potential differences (V1, V2) at inner portions (81, 82; 83, 84) of the respective current sensors."

Claims 2 to 5 of the respondent's main request are dependent on claim 1.

Reasons for the Decision

1. This decision is issued after the entry into force of the EPC 2000 on 13 December 2007 whereas the application was filed before this date. Reference is thus made to the relevant transitional provisions for the amended and new provisions of the EPC, from which it can be derived which Articles and Rules of the EPC 1973 are still applicable to the present application and which Articles and Rules of the EPC 2000 are to apply. When Articles or Rules of the former version of the EPC are cited, their citations are followed by the indication "1973" (cf. EPC, Citation practice).

2. Admissibility

The notice of appeal and the statement of grounds of appeal comply with the requirements of Articles 106 to 108 EPC and Rule 99 EPC. The appeal is thus admissible.

3. Respondent's main request - Inventive step (Article 56 EPC 1973)

- 3.1 The Board concurs with the parties and the opposition division that document D3 qualifies as closest prior art when deciding on the inventive merits of the claimed invention.

It is undisputed that document D3 discloses a power semiconductor module comprising all the features (a) to (f) of the preamble of claim 1 according to the feature analysis made by the appellant in the grounds of appeal (cf. section 3.1). In this respect, reference is made to section 3.2 of the grounds of appeal and to section 3 of the respondent's letter of 24 April 2009.

Moreover, the circuit branch including resistor 9 in the circuit of Figure 3 of D3 may be considered to form part of the primary current path so that the feature of the current sensor including a conductor provided in the primary current path is also known from D3.

- 3.2 The claimed subject-matter thus differs from the semiconductor module known from D3 in that:
- (g) the conductor includes parallel flat plates so as to have substantially U-character shape in section;
 - (h) a primary current is detected from a potential difference between inner portions of the conductor;
 - (i) the current sensing unit includes a second current sensor connected in series;
 - (j) the two current sensors have equal inductance;
 - (k) the two current sensors have different resistance;
 - (l) the primary current is detected from a difference between potential differences at inner portions of the respective current sensors.
- 3.3 Although the Board shares the analysis put forward by the appellant with regard to the absence of synergy resulting from the claimed combination of features

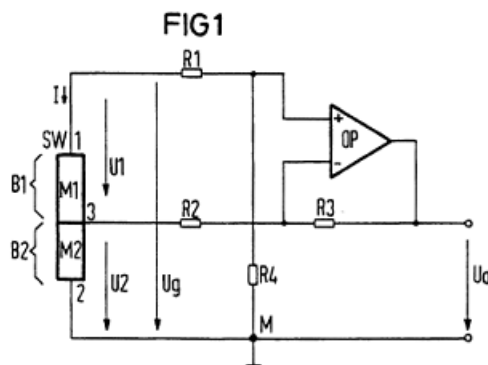
(cf. section 3.3.1 below) and the fact that the skilled person would have indeed considered documents D6 and D7 in order to solve the partial problems addressed by the invention (cf. section 3.3.2 below), it nevertheless rejects the view that the claimed invention would result in an obvious manner from the prior art. In the Board's judgement, the subject-matter resulting from the combination of document D3 with D6 and D7 would namely not fall under the definition of the claimed invention (cf. section 3.3.3 below). The Board also rejects the appellant's objection based on a combination of document D3 and common general knowledge (cf. section 3.3.4 below).

3.3.1 The Board essentially concurs with the appellant's view according to which the problem solved by the distinguishing features consists, in fact, of two partial problems which both affect the accuracy of current measurements. While features (g) and (h) permit to reduce inductance when detecting current, features (i) to (l) permit to compensate for the effect of residual inductance. In this respect, the Board rejects the respondent's argument according to which the elimination of the effects due to mutual inductances or the reduction of errors due to constructional tolerances in the manufacturing of the sensors would provide evidence for a synergy. These achievements result namely from the sole geometry of the current sensor as defined in feature (g) and thus do not constitute additional effects resulting, as such, from the claimed combination of features.

3.3.2 Document D7 relates to the field of electric current shunts for use in AC circuits carrying large currents. The use of shunts for current measurements is a well known technique which forms part of common general

knowledge, as was finally admitted by the respondent (cf. letter of 30 September 2013, page 5, third paragraph). Hence, although document D7 is completely silent about how to measure such currents, as was emphasised by the respondent, the Board considers that its teaching would have been taken into account by the skilled person when looking for a solution to improve the accuracy of current measurements. This is all the more true since D7 explicitly addresses the need to neutralise the effects of inductance (cf. column 1, lines 13, 14; column 2, lines 56-68; column 4, lines 66-70).

Document D6 refers to a shunt configuration used for measuring high currents (cf. column 1, lines 3-8). D6 addresses more specifically the problem resulting from the existence of self impedance when measuring high alternative currents (cf. column 1, lines 9-22; lines 39-42; column 3, lines 34-47). The problem is solved by providing two sensors with the same self inductance but different resistances as recited in granted claim 1.



Document D6: Figure 1

Consequently, the skilled person would have indeed considered the teaching of documents D6 and D7 when adapting the circuit disclosed in document D3 in order to eliminate or at least minimize to a large extent the

adverse effects resulting from the presence of inductances. More specifically, the skilled person would have undoubtedly recognised the benefits of the U-shaped sensors disclosed in D7 and which advantages, in terms of accuracy, would result from the differential configuration proposed in document D6 (cf. Figure 1).

3.3.3 However, as put forward by the respondent, the adaptation of the circuit of Figure 3 in D3 in the light of documents D6 and D7 does not lead to the claimed power semiconductor module. It is noted that the module resulting from such adaptation would include the circuit of Figure 1 in D6 as reproduced above. In this respect, it is acknowledged that the output potential U_a in D6 (cf. Figure 1) is indeed representative of the primary current and **reflects** the difference $U_1 - U_2$ (cf. column 4, lines 8-26). In other words, although no direct measurements of U_1 and U_2 is actually carried out in D6, the selection of the various resistances in the circuitry is such that the output potential U_a **is indeed indicative of** said difference, i.e. indicative of a difference between potential differences at inner portions of the respective current sensors. However, there is still a difference with respect to the claimed configuration which namely requires that the primary current be "**detected from a difference between potential differences (V_1, V_2) at inner portions (81, 82; 83, 84) of the respective current sensors [emphasis added]**" which implies, in the Board's judgement, that potential differences at inner portions of the current sensors be effectively measured. This is not the case in the arrangement disclosed in Figure 1 of document D6 where the output potential U_a is affected by the presence of resistances R_1 to R_4 and of the operational amplifier

OP. Thus, a direct measurement fails in the circuit of D6.

- 3.3.4 The Board also rejects the alternative argumentation put forward by the appellant according to which U-shaped current sensors as well as differential measurement techniques formed part of general knowledge in the field of current measurements so that the claimed invention would result in a straightforward manner from the adaptation of the circuit of Figure 3 in document D3 in view of this general knowledge.

The Board observes, in this respect, that the respondent did not provide evidence of the general knowledge referred to, despite having been challenged to do so by the respondent. Moreover, it is established jurisprudence of the boards of appeal that patent documents normally do not constitute evidence of such knowledge. Documents D6 and D7 must therefore be disregarded for that particular purpose.

- 3.3.5 For these reasons, the subject-matter of claim 1 of the main request meets the requirements of Article 56 EPC 1973 since it is considered to involve an inventive step.

Thus, the invoked ground for opposition under Article 100(a) EPC 1973 does not prejudice the maintenance of the European patent as granted.

4. Under these circumstances, there is no need for the Board to decide on the merits of the respondent's auxiliary requests.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



R. Schumacher

G. Assi

Decision electronically authenticated