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**Datasheet for the decision
of 25 October 2006**

Case Number: T 1005/04 - 3.5.02

Application Number: 94308087.9

Publication Number: 0652630

IPC: H02M 1/00

Language of the proceedings: EN

Title of invention:
Semiconductor stack

Patentee:
KABUSHIKI KAISHA TOSHIBA

Opponent:
Siemens AG

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no)"

Decisions cited:
-

Catchword:
-



Case Number: T 1005/04 - 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 25 October 2006

Appellant: Siemens AG
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Representative: -

Respondent: KABUSHIKI KAISHA TOSHIBA
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Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
15 June 2004 concerning maintenance of the
European patent No. 0652630 in amended form.

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: J.-M. Cannard
C. Holtz

Summary of Facts and Submissions

I. The opponent appealed against the decision of the opposition division concerning the maintenance of European patent No. 0 652 630 in amended form in accordance with the proprietor's main request filed on 5 May 2004 during the oral proceedings before the opposition division.

II. Prior art documents:

D1: DE 34 20 535 A1, and

D2: DE 89 09 246 U1,

considered during the first proceedings before the opposition division, remain relevant to the present appeal.

During the appeal, the appellant referred to the following documents:

D4: Products "IGBT 1200V SIXPACK" from the firm Eupec, and

D5: IGBT Module: $U_{CEmax} = 3.3$ kV, $I_{CN} = 1200$ A (Infineon) from the firm Siemens,

which were filed for the first time with the opponent's statement of grounds of appeal.

III. Claim 1 as maintained by the opposition division reads as follows:

"A semiconductor stack (7A) having a base member (6a), and a semiconductor assembly member, provided on said base member, including a switching element (1a-1c, 2a-2c) having a first terminal, a second terminal and a third terminal, mounted on a surface of said base member such that said first, second and third terminals of said switching element end at a common plane, whereby

said semiconductor assembly member further including,

a batch laminated conductor (8,16) positioned on said first, second and third terminals of said switching element, composed of superimposition of a first conductor (3b), a second conductor (5b), a third conductor (4b) and insulators (20b, 21b, 22b, 23b) for insulating between adjacent two of said conductors,

first connecting means (PB1-PB6, 13) including terminal conductor bolts (13) for electrically connecting said first conductor (3b) to said first terminal (C) of said switching element, said first connecting means extending through said batch laminated conductor in a state in which said first connecting means is electrically connected to said first conductor and is insulated from said second and third conductors,

second connecting means (ACB1-ACB12, 13) including terminal conductor bolts (13) for electrically connecting said second conductor (5b) to said second terminal of said switching element, said second connecting means extending through said batch laminated conductor in a state in which said second connecting means is electrically connected to said second

conductor and is insulated from said first and third conductors, and

third connecting means (NB1-NB6,13) including terminal conductor bolts (13) for electrically connecting said third conductor (4b) to said third terminal (E) of said switching element, said third connecting means extending through said batch laminated conductor in a state in which said third connecting means is electrically connected to said third conductor and is insulated from said first and second conductors."

Claims 2 to 10 are dependent on claim 1.

IV. Oral proceedings were held on 25 October 2006.

V. The arguments of the appellant opponent may be summarized as follows:

The semiconductor stack according to claim 1 differed from the semiconductor stack disclosed in document D1 only in that the terminals of the switching element were connected to the conductors of a batch laminated conductor by means of terminal conductor bolts, while the terminals of the switching elements of D1 were connected to the conductors of a batch laminated conductor by means of pins soldered in metallised holes.

The objective technical problem would consist in making the semiconductor stack of D1 suitable for switching high currents. At the priority date of the patent in suit, it was usual for high power semiconductor modules to be provided with connecting means including

conductor bolts. The skilled person would have considered the combination of the teachings of documents D1 and D2 because in both these documents a batch laminated conductor was used in order to suppress surge voltages generated during switching operations by reducing the parasitic circuit reactance in a power converter. It would be obvious to replace the pins and metallised holes connecting the switching device of D1 by connecting means including terminal conductor bolts following the teaching of D2 in which the terminals of a capacitor were connected to the conductors of the laminated conductor by conductor bolts.

VI. The arguments of the respondent proprietor may be summarized as follows:

The terminals of the switching element of D1 did not end at a common plane. Neither the terminals B, E, C of the switching element of D1, nor the wire-wrap connections between the bond wires soldered to said terminals and the pins connected to the conductors of the batch laminated conductor in D1 were in a common plane. The terminals of the switching element of D1 were not connected to the batch laminated conductor by terminal conductor bolts.

There was no obvious way of starting from D1 and arriving at the arrangement of claim 1, irrespective of there being a problem or not. It would be unrealistic to combine features of the semiconductor stack according to D1 with features of the capacitor battery disclosed in D2 because their only clear common feature was the fact that they included a "laminated conductor". The stack of D1 comprised planar switching

semiconductors which were not suitable for switching large currents. The terminal bolts of D2 were simply connecting a "canister type" condenser to the conductors of a "laminated conductor". It was not possible without hindsight to extract some elements of D2, such as the connecting bolts, and use them in the context of D1 for connecting the wired terminals of a switching element to the three conductors of a batch laminated conductor.

VII. The appellant (opponent) requested that the decision under appeal be set aside and that the European patent No. 0 652 630 be revoked.

VIII. The respondent (patentee) requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

Scope of claim 1

2. Claim 1 relates to a semiconductor stack which includes a switching element having a first, a second and a third terminal which are respectively connected to a first, a second and a third conductor of a batch laminated conductor. According to dependent claim 7 and the embodiment described in the patent in suit (published patent, column 7, lines 1 to 3 and 29 to 31; column 8, lines 1 to 11; figure 1), this switching element can be composed of a positive switching device and a negative switching device connected in series,

wherein the first terminal of said switching element includes a positive terminal of said positive switching device, the second terminal of said switching element includes a negative terminal of said positive switching device and a positive terminal of said negative switching device, and the third terminal of said switching element includes a negative terminal of said negative switching device. The scope of claim 1 thus is so broad as to cover a stack whose switching element includes two such interconnected switching devices.

Inventive step

3. Document D1, which is the undisputed closest prior art, discloses a semiconductor stack which comprises the following features (see D1, figures 8, 9, 11 and 13; page 14, line 11 to page 20, line 20):

- a base member (74),

- a semiconductor assembly (figures 11 and 13) including a switching element (150, 152) having a first terminal (collector C of T1), a second terminal (emitter E of T1 and collector C of T2') and a third terminal (emitter E of T2'),

- a batch laminated conductor (124) composed of a first (128), a second (126) and a third (130) conductor, and insulators for insulating between adjacent two of said conductors (figures 8, 13; pages 16 and 17, bridging paragraph),

- first connecting means connecting said first conductor (128) to the first terminal (C of T1) of the

switching element, second connecting means connecting said second conductor (126,126',126'') to the second terminal of the switching element and third connecting means connecting said third conductor (130) to the third terminal (E of T2') of the switching element (figures 11 and 13; page 17, lines 19 to 21; page 20, lines 4 to 17),

- each of said connecting means (for instance, pins 114 and 116) extending through the batch laminator in a state in which it is electrically connected to one of said conductors and insulated from the two other conductors.

3.1 Terminals of a switching element are the parts of this element through which the electrical signals enter or leave the switching element. Since the switching devices (150, 152) included in the switching element of D1 are disposed on the base member (74) under a top plate (100) supporting the contact pins, and the space between the base member and the top plate can be filled with a protecting material (D1, page 15, last four lines), the terminals of the switching element of D1 are necessarily formed on the top plate (100) at the points where the bond wires from the switching devices are wrapped round the upstanding pins. The terminals in D1 thus end at a common plane (100), as recited in claim 1.

3.2 Therefore, the stack according to claim 1, in which the connecting means connecting the terminals of the switching element to the conductors of the batch laminated conductor include terminal conductor bolts, differs only in this respect from the stack disclosed

in D1 in which said connecting means are made by pins (114, 116) interacting with metallised holes.

4. The claimed semiconductor stack and the semiconductor stack disclosed in D1 are both for use in high-frequency pulse width modulators, which may be included in power converters, the batch laminated conductor included in these stacks making the circuit reactance smaller to suppress surge voltages generated during switching operations (patent specification, paragraphs [002] and [0013]; D1, page 4, last paragraph; page 5, line 7 to page 6, line 15 and page 14, lines 4 to 10). Although the modulators disclosed in D1 are configured for switching relatively low currents (for instance 30A, see page 21, line 7), the stack of the invention is more specifically concerned with the reduction of the circuit reactance in power converters using large capacity switching devices.
5. Accordingly, starting from D1 and having regard to the effect provided by the claimed invention, the objective technical problem addressed by the invention can be seen as providing a semiconductor stack for power converters which are equipped with large capacity switching devices, in other words: providing a high power version of the stack of D1.
6. In the judgment of the Board, the subject-matter of present claim 1 does not involve an inventive step having regard to the teachings of documents D1 and D2 taken in combination with the common knowledge of the skilled person.

- 6.1 The appellant stated that at the priority date of the patent in suit the switching devices available for high power applications were equipped with terminals for receiving terminal conductor bolts. In this respect, the Board is aware that, at that date, it was common practice for the skilled man to use terminal conductor bolts for connecting large capacity circuit devices in high power converters, as appearing more particularly from document D2.
- 6.2 D2 relates to a capacitor battery which is used as an intermediate constant current source for large capacity power converters. In the prior art capacitor battery referred to in D2, the capacitors are connected by bus bars, which are known to be used in high current applications, by means of terminal conductor bolts (page 1, lines 6 to 18).
- 6.3 The capacitor batteries disclosed in D2 have a function similar to the function of the battery B which forms the constant current source in the pulse width modulator described in figure 10 of D1. In order to reduce the circuit reactance of the prior art capacitor battery, the capacitors according to a first embodiment of D2 (page 4, line 16 to page 6, line 16; figure 2) are connected together by a batch laminated conductor similar to the batch laminated conductor described in D1. Therefore the skilled person starting from D1 and faced with the technical problem addressed by the invention would consider the teaching of D2 which belongs to the technical field of the power converters, as does the modulator according to D1, provides the same solution for suppressing surge voltages generated during switching operations by reducing to the circuit

- reactance by means of a batch laminated conductor, and is concerned with high current connecting means.
- 6.4 According to figure 2 of D2, the batch laminated conductor comprises four conductors (30,32,34,36) and insulators (38,40,42) disposed between these conductors. A first and a second one of said conductors are respectively connected to a first and a second terminal of a capacitor element by first and second connecting means including terminal conductor bolts (50,52), said bolts extending through the batch laminated conductor in a state in which each bolt is electrically connected to one of said terminals and insulated from the other terminal. Starting from D1, the skilled person faced with the objective technical problem of the invention, i.e. connecting terminals of high current switching devices to the conductors of a batch laminated conductor, would thus consider connecting means including terminal conductor bolts for connecting the terminals of the switching element to the conductors of the batch laminated conductor in the stack of D1 and implement such connecting means in an obvious way following the teaching of D2. Such a stack would comprise all the features of present claim 1.
7. The Board concludes therefore that the subject-matter of claim 1 does not involve an inventive step within the meaning of Article 56 EPC, so that the ground for opposition mentioned in Article 100a EPC prejudices the maintenance of the patent.

Order

For these reasons it is decided that :

1. The decision under appeal is set aside.
2. European patent No. 0 652 630 is revoked.

The Registrar:

The Chairman:

U. Bultmann

W. J. L. Wheeler