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**Datasheet for the decision
of 24 March 2026**

Case Number: T 0747/23 - 3.5.01

Application Number: 16877576.5

Publication Number: 3396842

IPC: H02M7/797, H02M7/5387,
H02M7/5388, H02M1/42

Language of the proceedings: EN

Title of invention:

BIDIRECTIONAL CONVERSION CIRCUIT AND BIDIRECTIONAL CONVERTER

Applicant:

Shenzhen Yinwang Intelligent
Technologies Co., Ltd.

Headword:

Bidirectional conversion circuit and bidirectional converter/
SHENZHEN YINWANG INTELLIGENT TECHNOLOGIES

Relevant legal provisions:

EPC Art. 56, 84, 111(1)
RPBA 2020 Art. 11, 12(4), 13(2)

Keyword:

Claims - clarity - main request (no) - missing essential features
Admissibility of auxiliary request (no) - request reintroduced after being abandoned in first instance proceedings
Amendment after communication pursuant to Article 15(1) RPBA - exceptional circumstances (yes)
Amendment after communication pursuant to Article 15(1) RPBA - new objection raised in the communication pursuant to Article 15(1) RPBA
Remittal - special reasons for remittal (yes)
Appeal decision - remittal to the department of first instance (yes)

Decisions cited:

G 0010/93, T 1420/06



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Case Number: T 0747/23 - 3.5.01

D E C I S I O N
of Technical Board of Appeal 3.5.01
of 24 March 2026

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Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted/electronically
transmitted on 4 November 2022 refusing European
patent application No. 16877576.5 pursuant to
Article 97(2) EPC.**

Composition of the Board:

Chairwoman I. Kürten
Members: M. Höhn
E. Mille

Summary of Facts and Submissions

- I. This appeal is against the decision of the examining division refusing European patent application No. 16877576.5 pursuant to Article 97(2) EPC on the ground of lack of inventive step (Article 56 EPC) with regard to prior-art publications:
- D6: Maksimovic, Dragan et al: "Chapter 19 Resonant Conversion" in: "Fundamentals of Power Electronics", 31 December 2001, Retrieved from the Internet: URL:https://www.ieee.li/pdf/introduction_to_power_electronics/chapter_19 and
- D7: EP 1 590 992 A1.
- II. In the statement setting out the grounds of appeal, the appellant requested that the appealed decision be set aside and that a patent be granted on the basis of the main request (claim set filed on 21 July 2022) or of an auxiliary request (claim set filed in the first instance proceedings on 15 April 2021). Oral proceedings were requested as an auxiliary measure if the main request was not granted.
- III. In its communication issued with the summons to oral proceedings, the Board expressed its preliminary opinion that claim 1 according to the main request did not fulfil the requirements of the EPC. Depending on whether the effect put forward by the appellant in relation to the distinguishing features was considered to fall within the skilled person's common general knowledge, the claim was considered to either lack inventive step under Article 56 EPC in view of D6 combined with D7 and the skilled person's common

general knowledge, or, if that effect was not considered part of the common general knowledge, it would not be derivable from the application as filed, resulting in a lack of sufficiency of disclosure under Article 83 EPC. The claim was also found to lack clarity under Article 84 EPC due to missing essential features relating to necessary operating conditions. Regarding the auxiliary request, the Board was minded not to admit it into the appeal proceedings.

- IV. In a reply dated 30 December 2025, the appellant submitted a second auxiliary request as well as further arguments in favour of admissibility and inventive step for all requests.
- V. Oral proceedings were held on 24 March 2026 as a videoconference.

The appellant's final requests were that the decision under appeal be set aside and that a patent be granted on the basis of the set of claims of the main request filed on 21 July 2022, or alternatively of the first auxiliary request filed on 15 April 2021 and subsequently abandoned, or of the second auxiliary request filed with letter dated 30 December 2025, and alternatively that the case be remitted to the examining division for further prosecution on the basis of the set of claims of the second auxiliary request.

After due consideration of the appellant's arguments, the Chair announced the decision.

- VI. Independent claim 1 according to the main request reads as follows:

"1. A bidirectional conversion circuit, comprising:
a first bidirectional conduction network (D1d), a
second bidirectional conduction network (D2d), a first
switching transistor (S1), a second switching
transistor (S2), a first diode (D1a), and a second
diode (D2a), wherein
the first bidirectional conduction network (D1d) and
the first switching transistor (S1) are connected in
series to form a first branch, wherein a first end of
the first branch is connected to a cathode of the first
diode (D1a) to form a first endpoint;
the second bidirectional conduction network (D2d) and
the second switching transistor (S2) are connected in
series to form a second branch, wherein a second end of
the second branch is connected to an anode of the
second diode (D2a) to form a third endpoint, wherein
the first bidirectional conduction network (D1d) and/or
the second bidirectional conduction network (D2d) are
two parallel diodes D1 and D2 having opposite
polarities;
a second end of the first branch, an anode of the first
diode (D1a), a first end of the second branch, and a
cathode of the second diode (D2a) are connected to form
a second endpoint;
the first switching transistor (S1) is turned on from a
first time to a second time, and is turned off from the
second time to a fifth time; and
the second switching transistor (S2) is turned off from
the first time to a third time, is turned on from the
third time to a fourth time, and is turned off from the
fourth time to the fifth time, wherein
the first time is a start time of a positive half cycle
of a current flowing into or flowing out of the second
endpoint, the third time is an end time of the positive
half cycle of the current, the second time is any time
within a time interval from the first time to the third

time, the fifth time is an end time of a negative half cycle of the current, and the fourth time is any time within a time interval from the third time to the fifth time."

VII. The Board notes that the claim set filed in the first instance proceedings on 15 April 2021 (now first auxiliary request) was replaced by the main request filed with the letter dated 21 July 2022. The appellant thereby returned on appeal to a claim set which had been abandoned during the first instance proceedings.

VIII. Claim 1 of the second auxiliary request adds to the end of claim 1 according to the main request:

"wherein a conduction voltage drop of the first bidirectional conduction network (D1d) is less than a conduction voltage drop of the first diode (D1a), and a sum of the conduction voltage drop of the first bidirectional conduction network (D1d) and a conduction voltage drop of a parasitic diode of the first switching transistor (S1) is greater than the conduction voltage drop of the first diode (D1a); and
a conduction voltage drop of the second bidirectional conduction network (D2d) is less than a conduction voltage drop of the second diode (D2a), and a sum of the conduction voltage drop of the second bidirectional conduction network (D2d) and a conduction voltage drop of a parasitic diode of the second switching transistor (S2) is greater than the conduction voltage drop of the second diode (D2a)."

Reasons for the Decision

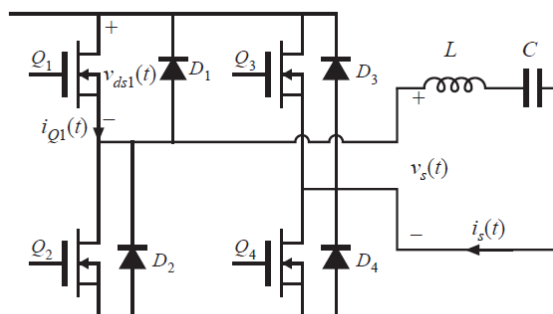
1. The invention concerns a bidirectional conversion circuit in the scenario of synchronous rectification. It addresses the problem of generation of a reverse recovery current in the circuit (paragraphs [0002] to [0005] of the published application).

Main request

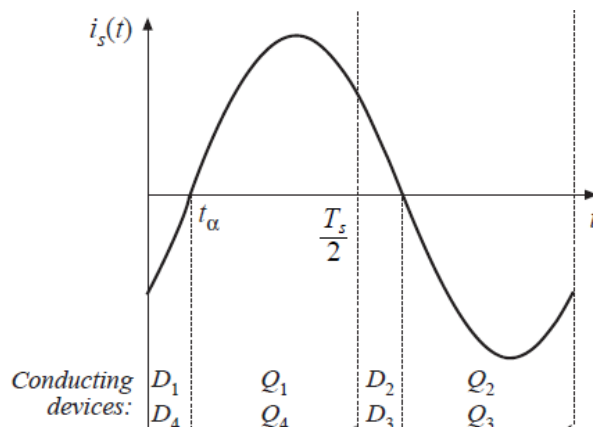
Article 56 EPC - Inventive step

2. The Board agrees with the contested decision that the features outlined in point 15.1.1 of the decision are known from the closest prior art D6. In particular, and in contrast to the appellant's arguments, D6 is considered to be pertinent prior art and a suitable starting point for assessing inventive step, because it is also directed to bidirectional synchronous rectification and implicitly addresses the problem of avoiding recovery currents with the zero voltage switching mode (see pages 63 to 66).

D6 discloses a H-bridge circuit, the left leg of which comprises first and second transistors Q_1 and Q_2 and diodes D_1 and D_2 :



D6 further discloses on page 63 a time diagram of a current $i_s(t)$ flowing into or flowing out of a point in the circuit corresponding to the second endpoint according to claim 1 and as shown in Figure 3A of the application:



When considering one leg of the H-bridge with transistors Q_1 and Q_2 , these are controlled by being turned on and off at different times corresponding to the first to fifth times in claim 1, in the following referred to as t_1 - t_5 .

- the first switching transistor (Q_1) is turned on from a first time t_1 to a second time t_2 (interval Q_1), and is turned off from the second time t_2 to a fifth time t_5 (intervals D_2 , Q_2 and D_1);
- the second switching transistor (Q_2) is turned off from the first time t_1 to a third time t_3 (see diagram above), is turned on from the third time t_3 to a fourth time t_4 (interval Q_2), and is turned off from the fourth time t_4 to the fifth time t_5 (see diagram above);

- the first time t_1 is a start time of a positive half cycle of a current flowing into or flowing out of the second endpoint (interval Q_1);
- the third time t_3 is an end time of the positive half cycle of the current (end of interval D_2);
- the second time t_2 is any time within a time interval from the first time t_1 to the third time t_3 (between Q_1 and D_2);
- the fifth time t_5 is an end time of a negative half cycle of the current (end of interval D_1);
- the fourth time t_4 is any time within a time interval from the third time t_3 to the fifth time t_5 (between intervals Q_2 and D_1).

The directions of the current in the above mentioned intervals therefore correspond to Figures 4A to 4D of the application as follows:

Fig. 4A - Q_1

Fig. 4B - D_2

Fig. 4C - Q_2

Fig. 4D - D_1

3. In the Board's view, the circuit according to D6 thereby achieves the same switching pattern as the claimed invention and, hence, also the effect of avoiding a reverse recovery current in the circuit.
4. The Board therefore agrees with the contested decision and with the appellant (see letter dated 30 December 2025, page 1) that the subject-matter of claim 1 differs from the disclosure of D6 in the provision of a first and second bidirectional conduction network, at least one of which has two parallel diodes having opposite polarities (see point 15.1.2 of the decision).

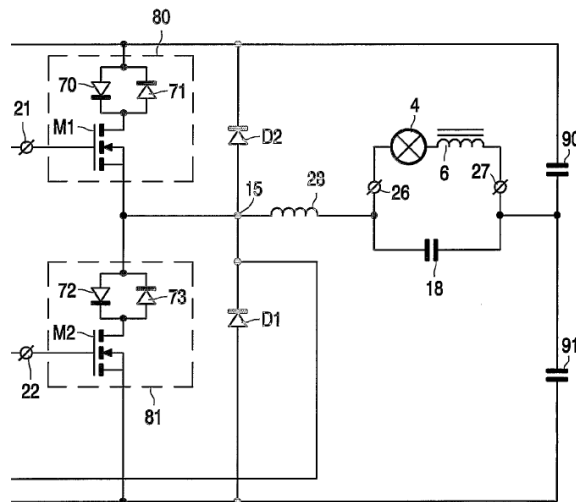
5. In the contested decision, the examining division formulated the objective technical problem as how to find an alternative implementation of an H-bridge leg or a half-bridge. The appellant disagreed with this problem formulation and argued that the distinguishing features, i.e. the first and second bidirectional conduction networks connected in series with the first and second switching transistors in first and second branches respectively, avoid the generation of a reverse recovery current in the circuit, thereby improving the performance of the bidirectional conversion circuit. This included improved safety of the circuit, considering that the reverse recovery current of a parasitic diode may be relatively large (reply to the communication pursuant to Article 15(1) RPBA, paragraph bridging pages 1 and 2).

On that basis, the appellant formulated the objective technical problem as how to improve the electrical safety of the circuit illustrated on page 63 of D6.

6. According to the appellant, publication D7 would not guide the skilled person to the claimed solution, in particular because both D6 and D7 described zero voltage switching for the purpose of reducing switching losses. The skilled person aiming to improve the electrical safety of the circuit illustrated on page 63 of D6 would have no motivation to incorporate the two diodes coupled in anti-parallel as shown in Figure 9 of D7 in isolation.
7. The Board does not agree. The skilled person, when dealing with the task of reducing switching losses in the field of power electronics, knows that reverse recovery current can lead to increased switching losses

and would naturally contemplate avoiding the generation of reverse recovery current. Since D6 and D7 both explicitly deal with zero voltage switching, the skilled person would consider combining the teaching of both documents.

8. D7 also concerns "zero voltage switching" (e.g. page 8, lines 9 and 11) as addressed in D6, pages 63 to 66, and would therefore be considered compatible by the skilled person. Figure 9 (reproduced below) shows a circuit with two switching transistors (M1, M2) according to a branch of a H-bridge as known from D6. Each of the switching transistors (M1, M2) is connected in series with a pair of anti-parallel diodes (70/71 and 72/73, see also claim 5 of D7). As in the present application, the disclosure of D7 is silent as to the function of such anti-parallel diodes, but the arrangements 80 and 81 come very close to the claimed solution.



9. In view of the principle that the skilled person has the same common general knowledge when interpreting both the application documents and the prior art, it is to be expected that, if the skilled person understands from the application that the anti-parallel diodes

connected in series with the transistors serve to avoid reverse recovery current and thereby improve electrical safety, they would understand the same when considering Figure 9 of D7. In view of the objective technical problem defined above, the skilled person would therefore combine the teachings of D6 and D7 and, in doing so, would arrive, without the exercise of inventive skill, at a circuit arrangement in which each switching transistor is connected with a pair of anti-parallel diodes, as disclosed in D7, thus leading directly to the claimed solution. Accordingly, the subject-matter of claim 1 lacks an inventive step (Article 56 EPC).

Article 84 EPC - Missing essential features

10. During the appeal proceedings, the Board raised the question whether the skilled person would understand from claim 1 what is the purpose of the anti-parallel diodes and whether the distinguishing features actually solve the problem posed.

The application as filed deals with the problem of reverse recovery current in the scenario of synchronous rectification (see paragraph [0006]). However, it does not explicitly state that the bidirectional conduction networks in the form of two anti-parallel diodes serve to avoid such reverse recovery current. Rather, it is left to the skilled person and their common general knowledge to infer this. However, if so, it must be assumed that this function of having anti-parallel diodes was already commonly known in the art.

When asked during the oral proceedings what was the concrete contribution of the bidirectional conduction networks to solving the reverse recovery problem, the

appellant argued that the skilled person would be able to select suitable diodes for the bidirectional conduction networks according to claim 1. At the same time and in contrast thereto, the appellant criticised that D7 gives no reasons for the use of anti-parallel diodes (see reply to the communication pursuant to Article 15(1) RPBA, page 2, sixth paragraph; repeated during oral proceedings).

11. When reading the description, the operating conditions set out in original claim 4 and in paragraph [0011] of the A1-publication of the application are described in a way that implies that these conditions have to be met in order to achieve the alleged effect of improved safety by avoiding reverse recovery current (see also [0045; 0046; 0048]). These operating conditions correspond to the features specified in present dependent claim 2, namely:

- a conduction voltage drop of the first bidirectional conduction network (D1d) is less than a conduction voltage drop of the first diode (D1a), and a sum of the conduction voltage drop of the first bidirectional conduction network (D1d) and a conduction voltage drop of a parasitic diode of the first switching transistor (S1) is greater than the conduction voltage drop of the first diode (D1a);
- and correspondingly for the second bidirectional conduction network (D2d).

Since current preferentially flows through a circuit branch having a lower conduction voltage drop, these conditions ensure that current is enabled to flow through the first and second diodes D1a and D2a instead of through the first and second branches (see e.g. figures 4A to 4D). This prevents the generation of a

reverse recovery current in a switching transistor during synchronous rectification, thereby improving circuit performance and electrical safety.

12. In the Board's view, these relationships of the respective conduction voltage drops are essential features for the claimed invention and their omission from the independent claim gives rise to an objection under Article 84 EPC.

If the ratio between the respective conduction voltage drops was different, e.g. by specifying the dimensions of diodes D1a, D2a and D1d, D2d such that current would flow through the first and second branches instead of through the first and second diodes D1a, D2a, the problem of avoiding reverse recovery current in the switching transistors would not be solved. However, such embodiments are covered by present claim 1. The claim therefore does not solve the problem posed over the whole range claimed.

Thus, claim 1 does not fulfil the requirements of Article 84 EPC.

First auxiliary request

13. With the first auxiliary request the appellant returns to a set of claims which had been replaced during the first instance proceedings (see point VII. in the Facts and Submissions). These claims were not maintained and are not part of the contested decision. Nor can the amendments be regarded as a response to objections raised in the contested decision. Moreover, the appellant has not provided any indication why reintroducing formerly claimed matter is justified. This goes against the purpose of the appeal proceedings

which is the review of the first instance decision. Also in the reply to the communication pursuant to Article 15(1) RPBA, no convincing arguments justifying the reintroduction of a withdrawn request were presented.

The appellant's amendments therefore constitute an infringement of Article 12(2) RPBA. Furthermore, a corresponding request could have been maintained before the department of first instance in order to have it decided upon, Article 12(4) RPBA (see also T 1420/06). In particular, in view of the fact that the appellant did not attend the oral proceedings before the first instance, the appellant deliberately chose not to pursue the opportunity to present and defend such a request during the examination proceedings.

Therefore, the Board does not admit the first auxiliary request into the appeal proceedings.

Second auxiliary request

14. Claim 1 according to this request incorporates the features of original claim 4, which are considered to be essential. It thereby overcomes the objection under Article 84 EPC (see points 10 to 12 above).
15. Since this objection was raised for the first time with the communication pursuant to Article 15(1) RPBA, this constitutes exceptional circumstances under Article 13(2) RPBA and the Board admits this request into the appeal proceedings.
16. The examining division considered the subject-matter now incorporated into claim 1 to be obvious in view of Figure 9 of D7 (see item 15.2 of the contested

decision). However, no reasoning was given as to why the skilled person would consider the claimed ratio of conduction voltage drops of diodes and bidirectional conduction networks obvious which the Board could judicially review.

Similarly, in a communication dated 1 March 2022, when assessing inventive step of original claim 4, the examining division merely referred to D5 (WO 2015/079762 A1), paragraphs 10 and 11, as well as D4 (XUE LINGXIAO ET AL: "GaN-based high frequency totem-pole bridgeless PEG design with digital implementation", 2015 IEEE APPLIED POWER ELECTRONICS CONFERENCE AND EXPOSITION (APEC), IEEE, 15 March 2015, pages 759-766, XP032775284), paragraphs 7 and 8. However, no reasons were given as to why these passages would render the subject-matter of claim 4 obvious. In particular, no reasoning was provided as to why the skilled person would combine these teachings with the closest prior art D6.

17. Remittal

According to established case law, since the main purpose of appeal proceedings is to give a losing party an opportunity to challenge a decision on its merits, remittal in accordance with Article 111(1) EPC is an option to be considered by the Boards where essential questions regarding the patentability of the claimed subject-matter have not yet been examined and decided on by the department of first instance (see the Case Law of the boards of appeal, 11th edition, V.A. 9.3.2.a)). The primary purpose of *ex parte* appeal proceedings is to review the correctness of the decision under appeal (G 10/93, OJ 1995, 172, point 4 of the reasons), and not to perform examination on

matter which was not properly discussed in first instance proceedings.

The appellant has explicitly requested remittal of the case to the first instance on the basis of the second auxiliary request.

As a result, after considering all the relevant circumstances of the case at hand, the Board, noting that Article 11 RPBA cannot be seen as limiting the discretionary power of the Board provided by Article 111(1) EPC, considers it appropriate to remit the case to the examining division for further prosecution.

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 for further prosecution on the basis of the set of claims of the second auxiliary request.

The Registrar:

The Chairwoman:



T. Buschek

I. Kürten

Decision electronically authenticated