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**Datasheet for the decision  
of 8 July 2019**

**Case Number:** T 0558/15 - 3.5.02

**Application Number:** 08844429.4

**Publication Number:** 2218169

**IPC:** H02M7/06, H02M1/12

**Language of the proceedings:** EN

**Title of invention:**  
Bridgeless Boost AC-DC Converter

**Patent Proprietor:**  
Eltek Valere AS

**Opponent:**  
AEG Power Solutions B.V.

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

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



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Case Number: T 0558/15 - 3.5.02

**D E C I S I O N**  
**of Technical Board of Appeal 3.5.02**  
**of 8 July 2019**

**Appellant:** Eltek Valere AS  
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**Decision under appeal:** **Interlocutory decision of the Opposition  
Division of the European Patent Office posted on  
15 January 2015 concerning maintenance of the  
European Patent No. 2218169 in amended form.**

**Composition of the Board:**

**Chairman** R. Lord  
**Members:** F. Giesen  
W. Ungler

## **Summary of Facts and Submissions**

I. This appeal lies from the interlocutory decision of the Opposition Division posted on 15 January 2015 concerning maintenance of the European Patent No. 2218169 in amended form.

II. The Opposition Division had come to the conclusion that the converter of claim 1 according to the main request did not involve an inventive step in view of the following documents:

E1: US 7,265,650 B1

E8: "Bridgeless PFC Implementation Using One Cycle Control Technique"

Lu B., Brown R., Soldano M., APEC 2005, Twentieth Annual IEEE Applied Power Electronics Conference and Exposition (IEEE Cat. No. 05CH37646), Piscataway, NJ, USA, ISBN 0-7803-8975-1.

III. The patent proprietor (appellant) filed an appeal against this decision and requested with the statement of grounds of appeal dated 13 May 2015 that the impugned decision be set aside and a patent be maintained on the basis of the main request filed with the letter dated 1 July 2013. Additionally, they requested oral proceedings in case this request could not be allowed.

The opponent (respondent) did not file any reply to the appeal.

IV. Claim 1 according to the main request reads as follows:

*"Device arranged for converting an AC input voltage to a DC output voltage, comprising:*

- a bridgeless boost converter; and*
- a protection and stabilisation system comprising:*
  - a first diode (D2), where the anode is connected to a negative boost output terminal (Obn) and the cathode is connected to the first AC input terminal;*
  - a second diode (D4), where the anode is connected to the negative boost output terminal (Obn) and the cathode is connected to the second AC input terminal;*
  - a third diode (D1), where the anode is connected to a first AC input terminal and the cathode is connected to a positive boost output terminal (Obp); and*
  - a fourth diode (D3), where the anode is connected to a second AC input terminal and the cathode is connected to the positive boost output terminal (Obp);*

*characterized in that the protection and stabilisation system further comprises at least one capacitor connected in parallel with at least one of the protection and stabilization diodes (D1-D4)."*

V. The arguments of the appellant, in so far as they are relevant for the present decision, were essentially as follows:

The formulation of the objective technical problem used by the Opposition Division, namely reducing EMI in the prior art converter, was too general. The diodes D3 to D6 in the converter according to Figure 25 of E1

already reduced EMI. The problem of the present invention was actually to reduce EMI emerging from the protection and stabilisation diodes. The capacitors C1 and C2 in document E8 had the purpose of suppressing EMI resulting from parasitic capacitances between the output terminals of the converter, see Figure 12 and associated text. There was, however, no hint that the capacitors could reduce or prevent EMI emerging from the protection and stabilisation diodes. There was thus no motivation for the skilled person to provide the capacitors of E8 in the circuit of E1 in the claimed manner. At the priority date of the opposed patent voltage spikes over the protection and stabilisation diodes had not been known.

### **Reasons for the Decision**

1. The appeal is admissible
  
2. According to Article 12(3) RPBA, the Board may, subject to Articles 113 and 116 EPC decide the case at any time after the expiry of the time limit for the written reply to the statement of grounds of appeal. The appellant had requested oral proceedings only in the case that the Board could not allow their main request. The respondent has neither requested oral proceedings nor replied to the statement of grounds within or after the time limit extended by two months upon their request. Since the Board is in a position to allow the appellant's main request, the present decision can be delivered in writing.

3. Claim 1 according to the main request involves an inventive step over E1 in view of E8 for the following reasons:

3.1 Distinguishing features

It was not disputed by the appellant that the device arranged for converting AC input voltage to DC output voltage according to claim 1 of the main request differs from the converter disclosed in Figure 25 of document E1 by the feature in the characterising portion, namely in that the protection and stabilisation system further comprises at least one capacitor connected in parallel with at least one of the protection and stabilization diodes. It is apparent that the other features of claim 1 are disclosed in E1 by comparing an embodiment of claim 1 (that of Figure 4 of the patent in suit), reproduced here as Figure 1, with the circuit according to Figure 25 of E1, reproduced here as Figure 2.

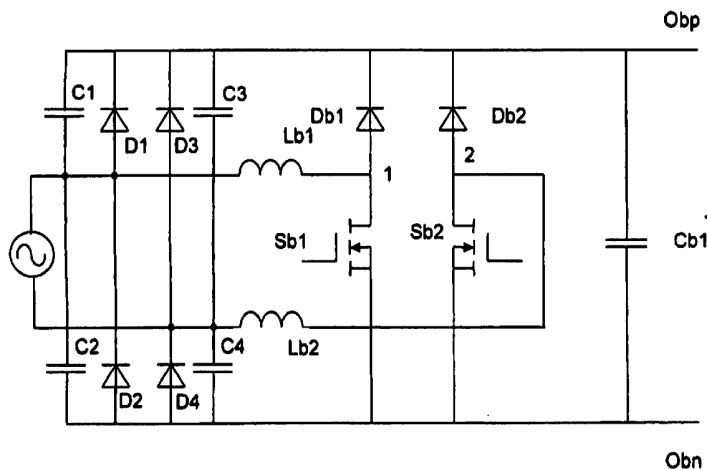


Figure 1: An embodiment in accordance with claim 1 of the main request.

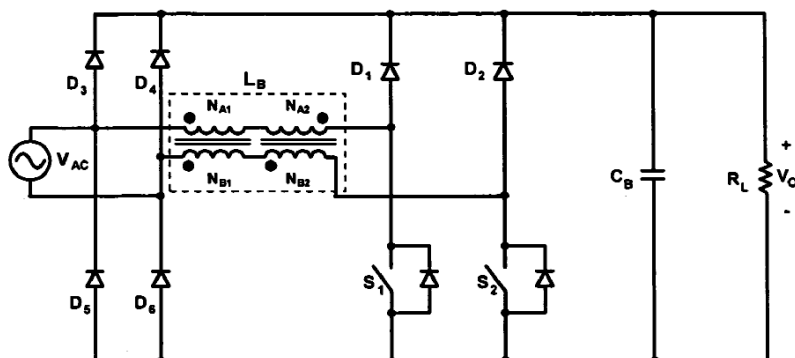


Figure 2: Circuit according to Figure 25 of E1.

### 3.2 Technical effect and technical problem

According to paragraph [0006] of the opposed patent, during the positive half cycle current will flow into the inductor  $L_{b1}$  and charge the capacitor  $C_{b1}$ , and the return current will flow in parallel through the diode  $D_4$  and inductor  $L_{b2}$ . According to Figure 2b and 3 of the opposed patent, the time profile of the current is essentially triangular. At the end of each half cycle, the current through the diode  $D_4$  goes to zero, which will cause the diode to block the current below a certain threshold voltage. On the contrary, current through the coil will continue to flow below the threshold voltage of the diode. As a consequence, every time the stabilisation diode is in the blocking mode and current is still flowing through the inductor, a voltage spike across the diode will occur, see Figures 2a and 3 of the opposed patent. This is true also for the negative half cycle. A capacitor in parallel to the diode will short-circuit this voltage spike and thus avoid EMI problems.

The technical problem is therefore, to avoid EMI and noise caused by the stabilisation diodes of the converter.

### 3.3 Assessment of the solution

Document E8 was accepted by the appellant as belonging to the state of the art according to Article 54(2) EPC. This document is also concerned with EMI in bridgeless converters and would therefore be consulted by a skilled person trying to solve the above problem.

The circuits according to E8 differ from those of E1 in not having stabilisation diodes. For these bridgeless converters the negative converter terminal is not connected to the input power source but floats relative to it due to the intervening closed switch. This leads to the charging of parasitic capacitances and is identified as the source of noise, see for example E8, Figure 12 and 13. As a remedy for this problem, E8 proposes to insert capacitors between the converter negative terminals and the AC power source terminals to provide for an effective high frequency shunt for the return current, so that it cannot charge the parasitic capacitances. E8 discloses that this measure is not necessary for the conventional bridge converters, because there is a connection between the negative converter terminal and the AC power source through the diodes for each half cycle, see E8, section C.

Since the bridgeless converter according to Figure 25 of E1 already has a connection from the negative converter terminal to AC power source terminals through the stabilisation diodes, e.g. diodes D5 and D6, the skilled person would recognise that the noise mechanism described in E8 will not occur in the device according to E1. There is therefore no motivation for a skilled person to implement such a countermeasure (i.e. place capacitors between the converter ground and the AC



source terminals) because the noise source is not present in the device according to E1.

- 3.4 For these reasons, the converter according to claim 1 according to the main request involves an inventive step within the meaning of Article 56 EPC when starting from E1 in view of E8.
  
4. The remaining prior art cited by the respondent during the opposition proceedings is no more relevant for the assessment of inventive step than E1 and E8, for reasons corresponding to those given in the decision under appeal with respect to the auxiliary request. No further objections to the main request were raised during the opposition procedure. The board therefore concludes that the patent according to the main request and the invention to which it relates meet requirements of the EPC, so that the board has to accede to the main request of the appellant.

## Order

### For these reasons it is decided that:

1. The impugned decision is set aside.
2. The case is remitted to the Opposition Division with the order to maintain the opposed patent in amended form based in the following version:

Claims: 1 to 9 of the main request filed with the letter dated 1 July 2013.

Description: Paragraphs [0001] to [0037] of the patent specification.

Drawings: Figures 1 to 6 of the patent specification.

The Registrar:

The Chairman:



U. Bultmann

R. Lord

Decision electronically authenticated