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Datasheet for the decision of 20 January 2020

Case Number: T 0217/16 - 3.5.02

Application Number: 08854373.1

Publication Number: 2225822

IPC: H02M1/42

Language of the proceedings: EN

Title of invention:
Control system and method for controlling a bridgeless boost converter

Patent Proprietor:
Eltek Valere AS

Opponent:
ZTE Corporation

Relevant legal provisions:
EPC Art. 83, 111(1)

Keyword:
Sufficiency of disclosure - (yes)
Appeal decision - remittal to the department of first instance (yes)

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Beschwerdekammern

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Case Number: T 0217/16 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 20 January 2020

Appellant: (Patent Proprietor)	Eltek Valere AS P.O. Box 2340 Strømsø 3003 Drammen (NO)
Representative:	Onsagers AS Munkedamsveien 35 P.O. Box 1813 Vika 0123 Oslo (NO)
Respondent: (Opponent)	ZTE Corporation ZTE Plaza, Keji Road South Hi-Tech Industrial Park, Nanshan District Shenzhen, Guangdong 518057 (CN)
Representative:	Vossius & Partner Patentanwälte Rechtsanwälte mbB Siebertstrasse 3 81675 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 27 November 2015 revoking European patent No. 2225822 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman	R. Lord
Members:	C.D. Vassoille
	W. Ungler

Summary of Facts and Submissions

I. This is an appeal of the patent proprietor (appellant) against the decision of the opposition division to revoke European patent no. 2 225 822 on the ground of insufficiency of disclosure of the main request filed by the appellant with letter of 10 October 2013 (Article 83 EPC).

II. With the statement of grounds of appeal, the appellant filed a main request and auxiliary requests 1, 1-a, 2, 2-a, 3, 3-a, 4, 4-a, 5, 5-a, 6, 6-a, 7, 7-a. The main request corresponded to the main request (patent in amended form) on which the decision under appeal was based. With letter dated 11 January 2017, the appellant withdrew auxiliary requests 1 and 1-a.

III. The appellant (patent proprietor) requested in writing:

1. That the decision under appeal be set aside and the patent be maintained on the basis of the main request or, if this was not possible, of one of the auxiliary requests 2, 2-a, 3, 3-a, 4, 4-a, 5, 5-a,6, 6-a, 7 and 7-a, in that order, each of these requests submitted with the statement of grounds of appeal;

2. In the event that the first request could not be allowed, that the decision under appeal be set aside and the case be remitted to the department of first instance for further prosecution and examination of the further grounds for opposition (Articles 123, 54 and 56 EPC);

3. To hold oral proceedings in the event that the first request and the second request could not be allowed.

IV. The respondent (opponent) requested in writing:

1. That the appellant's appeal be dismissed;

2. In the event that the decision under appeal is to be set aside, that the case be remitted to the department of first instance for further prosecution and examining of the case with respect to Articles 123, 54 and 56 EPC;

3. In the event that neither of the first or the second request could be granted, that the contested patent be revoked in its entirety based on the grounds of opposition relating to Articles 123, 54 and 56 EPC;

4. To hold oral proceedings in the event that none of the first to third requests could be granted.

V. Both parties requested in writing that the case be remitted to the department of first instance, if the decision under appeal is to be set aside, and only if this request could not be granted, that oral proceedings be held.

Given the board's conclusions on the main request, the present decision is issued in the written procedure without holding oral proceedings.

VI. Claim 1 of the appellant's main request reads as follows:

"Control system for controlling a bridgeless boost converter, comprising:

- a first measuring unit measuring a first value representing a first current through a first boost switch (Sb1) of the bridgeless boost converter;
- a second measuring unit measuring a second value representing a second current through a second boost switch (Sb2) of the bridgeless boost converter;
- a third current measuring unit measuring a third value representing a third current representing the sum of the currents through the components of a stabilization system, where the stabilization system comprises:
  - a first impedance (Zs1) connected between a third node (3) and a first AC input terminal and a second impedance (Zs2) connected between the third node (3) and a second AC input terminal, or
  - a first stabilization diode (Dstab1) connected between the third node (3) and the first AC input terminal and a second stabilization diode (Dstab2) connected between the third node (3) and the second AC input terminal;

where a measured signal u_p is computed by means of the first, second and third currents, where a reference signal representing the input voltage Vac is formed, and where the measured signal u_p and the reference signal representing the input voltage Vac are input to the control system for controlling the switches (Sb1, Sb2) so that the measured signal u_p is substantially in phase with the reference signal representing the input voltage Vac."

Claims 2 to 5 are dependent on claim 1.

VII. Independent method claim 6 of the appellant's main request reads as follows:

"Method for controlling a bridgeless boost converter, comprising:

- measuring a first value representing the current through a first boost switch (Sb1) of the bridgeless boost converter;
- measuring a second value representing the current through the second boost switch (Sb2) of the bridgeless boost converter;
- measuring a third value representing a third current representing the sum of the currents through the components of a stabilization system, where the stabilization system comprises:
    - a first impedance (Zs1) connected between a third node (3) and a first AC input terminal and a second impedance (Zs2) connected between the third node (3) and a second AC input terminal, or
    - a first stabilization diode (Dstab1) connected between the third node (3) and the first AC input terminal and a second stabilization diode (Dstab2) connected between the third node (3) and the second AC input terminal;
- computing a measured signal u_p by means of the first, second and third currents,
- forming a reference signal representing the input voltage Vac,
- inputting the measured signal u_p and the reference signal to the control system for controlling the switches (Sb1, Sb2) so that the measured signal u_p is substantially in phase with the reference signal representing the input voltage Vac."

Claims 7 to 9 are dependent on claim 6.

In the light of the board's conclusions on the main request, it is not necessary to recite the auxiliary requests.

VIII. The appellant's arguments as far as they are relevant for the present decision are as follows:

The concept of power factor control (PFC) in bridgeless boost converter (BBC) systems was well known in the art. The skilled person was also perfectly aware of the fact that a PFC controller was designed to accept a signal representing the input current and another signal representing the input voltage and to provide switch control signals that control the BBC switches such that the input current was substantially in phase with the input voltage. The skilled person was well aware of how a PFC controller operated and there was no need to provide information in the contested patent on how to implement a PFC controller in order for the invention to be sufficiently disclosed.

The opposition division was wrong in their opinion that the step of choosing a maximum of two current sums of the input sensing scheme according to present invention required additional information as regards a "period of time" or "time section" in which the maximum of these currents had to be computed in order to yield the measured signal u_p. As was well known in the art of PFC, the signal representing the input current had to be measured or reconstructed sufficiently often during the period of the input current to allow the signal to be a true and accurate representation of the input current. The implementation of the signal processing disclosed in figures 6 and 7 of the contested patent was, as such, a routine operation for the skilled person. In particular, performing two summations of currents and determining which of these sums was larger belonged to the common general knowledge of the skilled person.

It was also known to the skilled person to reconstruct input currents from a signal indicative of the input current continuously using analog components, such as current transformers or differential mode amplifiers. Alternatively, it was well known in the art that the signals forming the basis for the input current measurement or reconstruction could be sampled using digital techniques.

When measuring the voltages over the measuring units R_{s1}, R_{s2} and R_{s3}, the skilled person would immediately understand that the measurements must be performed by comparison with a signal reference. In figures 1 to 4 of the contested patent, such a signal reference was indicated by the symbol:

This symbol indicated signal ground, i.e. a reference point from which one or a plurality of signals were measured.

The formula as presented in the contested patent represented the true input current. The symbols indicating signal ground did not represent physical grounding positions but only indicated reference positions for measurements. A circuit may have a plurality of signal ground positions, each having its own reference position suitably chosen for a particular measurement. The signal ground positions were not galvanically interconnected, which a skilled person would immediately understand. Interconnecting the signal grounds galvanically would short-circuit the measuring units R_{s1}, R_{s2} and R_{s3} and would thus result in a nonsensical circuit.

As described in paragraph [0033] of the contested patent, the measurements from the first, second and third measuring units were input to the control system. It was however clear from the above-mentioned paragraph that the elements for computing the input signal u_p may or may not be considered to be part of the control system.

IX. The respondent's arguments as far as they are relevant for the present decision are as follows:

Information on the period of time or time section for measuring the signal u_p was highly relevant to the implementation of the invention. The contested patent did not provide any information on the period of time or time section in which the maximum of the currents had to be computed in order to yield the measured signal u_p.

The signal u_p was not the input of the control system but three measured currents were fed into the control system to compute the signal u_p. A disclosure of the time-dependency of the measured current signals was indispensable for carrying out the invention. It was not within the common general knowledge of a skilled person to define said period of time or time section based on the overall poor information provided by the contested patent.

None of the frequencies used in the context of PFC in a BBC, i.e. a BBC input normally having a frequency of 50 to 60 Hz and a switching frequency of the BBC switches of typically 20 to 300 kHz, was disclosed in the contested patent. However, further information was needed as regards the sampling frequency, in particular

as different control methods had different requirements to be taken into account.

The contested patent did not contain any disclosure as regards the appellant's allegation that any known PFC control system may be used to implement the invention. Furthermore, no algorithm was disclosed that would suggest a procedure for controlling the switches Sb1 and Sb2 in a way that the signal u_p resulting from the combination of measurements is in phase with the reference signal representing the input voltage Vac.

A problem for the skilled person was the further processing of the signal u_p. The contested patent used the signal u_p to somehow control the signal u_p to be substantially in phase with the reference signal representing the input voltage. However, unlike in the prior art, the signal u_p was not a current through a resistor, but rather a calculated value of different measured current values. Thus, without further information on the signal u_p, known control systems could not be used for the scheme proposed by the contested Patent. Rather, it was completely unclear for the skilled person how to implement such a control system based on a signal u_p which was merely described as a discrete value of a maximum of sums of measured currents.

The formula to determine the measured signal u_p provided by the contested patent was incorrect. In order to obtain a true representation of the input current, the direction of the currents, i.e. their signs, would have to be taken into account.

The formula provided in the contested patent also did not represent the true input current because the signal

grounds of the circuit had to be assumed to be galvanically connected and the determination of the input voltage Vac according to figure 5 therefore had to be considered when calculating the signal u_p. The formula consequently would have to be further modified to take the resulting additional current into account, which was however not disclosed in the contested patent.

Reasons for the Decision

1. The appeal is admissible.

2. Sufficiency of disclosure (Article 83 EPC)

2.1 The patent discloses the invention in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art (Article 83 EPC).

2.2 The appellant in the statement of grounds of appeal correctly identified two different objections that the opposition division had raised in the reasons for the decision under appeal concerning the question as to whether the main request fulfilled the requirement of Article 83 EPC (see point 1.2 of the reasons for the decision under appeal).

2.3 The first of these objections relates to the absence of a definition of a time period or time section in the contested patent for measuring the currents in order to calculate the signal u_p.

The board generally agrees with the respondent that the time aspect to compute from three current values a

measured signal u_p is an important aspect in the context of the invention. It is also true that the contested patent does not specify a time period, time point or time section in which the maximum of the current sums has to be computed in order to yield the measured signal u_p. Nevertheless, the absence of such information in the contested patent alone is not sufficient to demonstrate that the skilled person could not carry out the invention.

To the contrary, the board has no doubts that the skilled person is able to complement this information without any difficulties in order to carry out the invention. As has been convincingly explained by the appellant, the signal u_p can be computed continuously throughout the period of the AC input signal using well known analog techniques. Alternatively, the currents I_{Rs1}, I_{Rs2} and I_{Rs3} can be sampled and the signal u_p can be computed at discrete points in time using well known digital components and techniques.

The board also agrees with the appellant that with respect to a "period of time" or "time section" for calculating or reconstructing the signal u_p representing the input current, no difference exists between the input current sensing scheme according to the invention of the contested patent and that of the prior art input current sensing schemes.

The board in conclusion further agrees with the appellant that the skilled person, depending on the circumstances, would choose sufficiently high computing frequencies to obtain a time dependent signal u_p as an accurate reproduction of the input current. It is thus not necessary for the contested patent to provide explicit information on a "period of time" or "time

section" in which the maximum is to be computed in order to yield the measured signal u_p.

No further convincing arguments in support of the respondent's allegation that the skilled person would in fact not know which period of time or time section to consider when applying the teaching of the contested patent have been presented. The opposition division in the decision under appeal merely stated in this respect that the explanations of the appellant (patent proprietor) were vague and that their statements would rather underline that it was necessary to disclose information concerning time periods in which the respective signals have to be determined.

However, the board observes that, as is the case with conventional input current measuring mechanisms, the signal representing the input current must be measured or reconstructed sufficiently often to allow the signal to be a true and accurate representation of the input current, as has been correctly argued by the appellant. As has been previously stated, the sole fact that the patent does not contain information on the time period or on the sampling time points does not necessarily imply that the invention cannot be carried out by the skilled person. Rather, the skilled person can complement this information and would readily understand when and how to sample currents I_{Rs1}, I_{Rs2}, I_{Rs3}. This applies also to different current modes and corresponding different control modes in the context of PFC.

Consequently, the absence of information about sampling time points or a time period/section in the present case does not hinder the skilled person from carrying out the invention.

2.4 The second of the opposition division's objections relates to a lack of disclosure of an algorithm for controlling the switches of a BBC.

The board considers that the skilled person is capable of implementing both the computation of the measured signal u_p and the PFC switching control by using established procedures and routines which are well known within the art of BBC PFC, as has been submitted by the appellant.

The board considers it to be in the legitimate interest of the appellant not to describe all aspects of the invention in any detail. As has been convincingly argued by the appellant, the skilled person is well aware of how to control the switches of a BBC in order to perform PFC so that the input current signal is substantially in phase with an input voltage signal. In the context of PFC, the board considers this to be a standard exercise for the skilled person. As has been explained by the appellant, during a period of the AC input, the switches are continuously switched on and off at a constant or varying switching frequency, which is significantly higher than the frequency of the AC input, whereby the relation of the on and off times of the switches is modulated to keep the input current substantially in phase with the input voltage, thus achieving power factor control.

The above findings also do not conflict with the fact that, according to the present invention, three currents I_{Rs1}, I_{Rs2}, I_{Rs3} are used to calculate a signal representing the input current. This is because the invention contains the formula u_p = MAX [(I_{Rs1}+I_{Rs3});

(I_{Rs2}+I_{Rs3})], which is a clear and unambiguous instruction on how to calculate this signal. Furthermore, the resulting signal u_p can be processed in the same way as a conventionally measured input current. The board in this respect observes that the sum of two currents is also a current and it is therefore not apparent why the resulting signal u_p as regards its further processing would differ from a conventionally measured input current. It is therefore not necessary for the contested patent to contain information in this respect.

Finally, the board observes that claim 1 recites "the measured signal u_p and the reference signal ... are input to the control system for controlling the switches". A corresponding feature is present in the independent method claim 6. According to this clear wording of the claim, the signal u_p is calculated outside of the control system for controlling the switches. As has been submitted by the appellant, figure 5 of the contested patent discloses the supply of the signal u_p to the control unit, which clearly implies a calculation of the signal u_p outside the control system for controlling the switches. The respondent's corresponding argument that a known control system for controlling the switches of the BBC cannot be used to implement the invention is therefore not convincing.

Even if, however, the signal u_p would be considered to be calculated within the control system for controlling the switches of the BBC, the board does not agree with the respondent that the person skilled in the art would not be able to implement this in connection with a commonly known switching control mechanism to perform PFC in a BBC. Rather, the skilled person must be

assumed to be able to implement a simple calculation according the formula in question "upstream" of a switching control on the basis of the calculated signal u_p.

In the decision under appeal the opposition division held that it was not convinced that any state of the art PFC boost converter control system could be used in the context of the present invention because the appellant only vaguely referred to the common general knowledge. It was further stated in the reasons for the decision that no algorithm for controlling the switches of the BBC is provided in the contested patent (see page 9 of the reasons for the decision under appeal).

The board however observes that the absence of an explicit disclosure of an algorithm for controlling the switches in the contested patent alone is not sufficient to justify the conclusion that the disclosure is insufficient in the sense of Article 83 EPC. Furthermore, for the invention to be carried out by the skilled person it is not necessary that "any" state of the art control system for controlling the switches of the BBC may be used. Rather, it is sufficient that the skilled person is aware of one way to implement the switching control. The board has no doubts that this is the case, given that the computed measured signal u_p is comparable to any other input current measured in accordance with the prior art PFC BBC. Consequently, the skilled person would know how to implement a control system for controlling the switches on the basis of the measured signal u_p, and it is therefore not necessary for the contested patent to explicitly disclose a specific algorithm to control the switches.

2.5 The board further observes that the question of whether the appellant's table on page 7 of the statement of grounds of appeal is flawed or not is irrelevant for determining whether the invention can be carried out by a skilled person in the sense of Article 83 EPC. Relevant in this respect would solely be the question of whether the formula u_p = MAX [(I_{Rs1}+I_{Rs3});(I_{Rs2}+I_{Rs3})] (paragraph [0033] of the contested patent) results in the calculation of the "true input current". The board has no doubts that this is the case.

The board is in particular not convinced by the respondent's arguments regarding the consideration of the direction and corresponding signs of the currents, which when applied to the above-cited formula of the contested patent, would allegedly result in the calculation of a maximum current which was not the "true input current".

The board recalls that the person skilled in the art reads the patent with the aim of understanding the invention. Only a deliberately wrongly applied understanding of the formula in question in connection with the converter circuit of the present invention can possibly lead to a wrong calculation of the input current. As can clearly be seen from the appellant's illustration of the flow of currents in the ON stage of the BBC switches for the positive and negative half cycles of the currents (see figures A and C of Appendix A of the appellant's letter dated 11 January 2017), the calculation of the measured signal u_p, by applying the formula u_p = MAX [(I_{Rs1}+I_{Rs3});(I_{Rs2}+I_{Rs3})] in the positive or negative half cycle, is a simple exercise for the person skilled in the art, bearing in mind that the skilled person is well aware that the formula serves to calculate the correct input current. As has been argued

by the appellant, the skilled person would readily understand from the description and drawings of the contested patent, which one of the sums of (I_{Rs1}+I_{Rs3}) and (I_{Rs2}+I_{Rs3}) is maximum in the positive or negative half cycles, and on or off states of the BBC switches, respectively. As is further evident from the letter dated 12 June 2017 (see point "Re 2.1"), also the respondent has no difficulties in determining the correct measured signal u_p, i.e. the correct sums of currents, from the formula in question.

Consequently, the board has come to the conclusion that the skilled person would not be hindered in any way from implementing the invention when applying the formula in question, which the skilled reader would understand and apply in a meaningful manner.

2.6 A further argument of the respondent referred to the signal ground illustrated in figures 1 to 5 of the contested patent. The respondent argued that in the absence of any information to the contrary it must be assumed that signal grounds are indeed galvanically connected resulting in an additional current flowing through the sampling diodes D3 or D4, which would have to be taken into account when calculating the input current.

The board does not agree with this. As has been argued by the appellant, not only would the skilled person immediately understand that a circuit may have a plurality of signal ground positions, which only indicate reference positions for measurements, and that interconnecting the signal grounds would result in a "nonsensical circuit" in the words of the appellant. The skilled person, when being confronted with the implementation of the present invention, would

therefore not take into account an obviously non-existent galvanic connection between signal grounds of the circuit.

2.7 The board has therefore come to the overall conclusion that the contested patent describes the invention according to claim 1 and corresponding method claim 6 in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art. The main request thus fulfils the requirement of Article 83 EPC. Since this was the sole ground in the decision under appeal relating to the main request, that decision has to be set aside.

3. Admittance of documents D10 to D17 into the appeal procedure

The appellant has requested that documents D10 to D17 be admitted into the appeal procedure. The respondent has requested that these documents not be admitted.

Given that the board, on the basis of the arguments presented by the parties in writing without consideration of the documents D10 to D17, has come to the conclusion that the invention is sufficiently disclosed for the skilled person to carry it out, it was not necessary for the board to decide on the admittance of these documents into the appeal procedure.

4. Remittal to the department of first instance

Both parties requested remittal of the case to the department of first instance for further prosecution in the event that the board sets the contested decision aside, and since the board does not see any special

reason to do otherwise, it had to accede to the parties' request.

The case is therefore remitted to the department of first instance for further prosecution and in particular for examination for compliance with the requirements of Articles 123(2), 54 and 56 EPC.

Order

For these reasons it is decided that:

1. The decision is set aside.

2. The case is remitted to the department of first instance for further prosecution.

The Registrar: The Chairman:

U. Bultmann R. Lord

Decision electronically authenticated