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Title of invention:
A Control Method and System for Assisting Active Power Factor Correction Loads

Applicant:
Lian Zheng Electronic (Shenzhen) Co., Ltd.

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - (no)

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Case Number: T 1500/20 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 23 May 2024

Appellant: (Applicant)	Lian Zheng Electronic (Shenzhen) Co., Ltd. No.4 Liufang Road Block 67 Baoan Shenzhen Guangdong 518101 (CN)
Representative:	Wagner & Geyer Partnerschaft mbB Patent- und Rechtsanwälte Gewürzmühlstrasse 5 80538 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 13 December 2019 refusing European patent application No. 12832440.7 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	R. Lord
Members:	G. Flyng
	W. Ungler

Summary of Facts and Submissions

I. The applicant's appeal contests the examining division's decision to refuse the European patent application 12 832 440.7.

II. The contested decision was based on the applicant's main request and auxiliary request, the claims of which were filed on 19 September 2019, and on the applicant's auxiliary requests II and III, the claims of which were filed during oral proceedings on 18 November 2019.

III. The examining division found that for a person skilled in the art starting from **US 5 784 268 A (document D1)**, the subject-matter of independent claims 1 and 6 of the main request and the auxiliary request was obvious, in the sense of Article 56 EPC, in view of their common general knowledge of the benefits associated with locking the phase of a square wave power supply to that of the commercial power source. They cited **US 5 473 533 A (document D2)** as evidence of that common general knowledge.

The examining division considered that when implementing the system of D1 with an output locked to the phase of the commercial power supply, the person skilled in the art would receive a clear hint from D1 that a (partial) pulse must be output immediately after switching to the battery. They further considered that a practical implementation of D1 would anyway force the skilled person to provide for such an immediate (partial) pulse if a sensitive load failed because of an excessively long power interruption.

Considering auxiliary requests II and III, the examining division recognised a technical difference in that the square wave output waveform was calculated to match an upper specification limit, which did not correspond to a pulse of maximum width as in D1. However, the examining division considered this distinguishing feature to be obvious for the skilled person applying D1 if loads with such a specification limit needed to be accommodated.

IV. With the statement of grounds of appeal, the appellant (applicant) refiled the main and auxiliary requests considered in the contested decision and submitted in essence that the amendments according to these requests did not contravene Article 123(2) EPC and that the subject-matter claimed met the requirements for novelty and inventive step.

V. The Board summoned the appellant to oral proceedings, setting out their preliminary observations in a communication pursuant to Article 15(1) RPBA. The Board explained *inter alia* that they tended to concur with the examining division's finding that the subject-matter of claims 1 and 6 of every request was obvious to the person skilled in the art when starting from the disclosure of document D1.

VI. With a letter dated and filed on 22 April 2024 the appellant filed sets of claims according to an amended main request and amended auxiliary requests I to III. These differed from the requests considered in the decision merely in the deletion of a comma from claim 1 for linguistic reasons. The appellant addressed the Board's observations *inter alia* on the question of inventive step.

VII. Oral proceeding were held on 23 May 2024. The appellant requested finally that the decision under appeal be set aside and that a patent be granted on the basis of the main request, or if that was not possible on the basis of one of the auxiliary requests I to III, all filed with the letter of 22 April 2024.

VIII. Independent claim 1 of the **main request** reads as follows:

"1. A method of operating a square wave power supply configured to provide power to a load from a battery source to support active power factor correction, APFC, loads, the method comprising:

providing a square wave output voltage waveform with pulse widths corresponding to effective output voltages above a desired nominal output voltage in response to respective transitions of the load from a commercial power source to the square wave power supply, wherein the pulse widths provided in response to the respective transitions are further dependent upon respective angles of a voltage of the commercial source at respective transitions when an upper specification limit is not reached before a dead zone requirement for changing a polarity of the output voltage waveform, such that in a first half-cycle of a voltage waveform reference synchronized to a voltage waveform of the commercial power source after a transition, the square wave power supply provides a pulse having a pulse width less than the upper specification limit and terminates with the start of a dead zone for a polarity change defined by the voltage waveform reference and, in a second half-cycle of the voltage waveform reference immediately following the first half-cycle, the square wave power supply provides a pulse having a width corresponding to the upper specification limit."

IX. Independent claim 1 of **auxiliary request I** is somewhat reworded compared to claim 1 of the main request, and reads as follows (highlighting added to identify the features amended in auxiliary requests II and III):

"1. A method of operating a square wave power supply configured to provide power to a load from a battery source to support active power factor correction, APFC, loads, the method comprising:

when transitioning the load from a commercial power source to the square wave power supply, providing a square wave output voltage waveform in phase with the phase of the commercial power supply, the square wave output voltage waveform having pulse widths, which correspond to an upper specification limit, corresponding to effective output voltages above a desired nominal output voltage,

wherein the pulse width in a first half-cycle of the square wave output voltage waveform after the transition is provided, dependent upon a respective angle of the voltage of the commercial power source at the transition, when a pulse having the upper specification limit cannot be output before a dead zone requirement for changing a polarity of the square wave output voltage waveform, such that the square wave power supply provides a pulse having a pulse width less than the upper specification limit and that terminates at the dead zone requirement for changing a polarity of the square wave output voltage waveform, and

wherein the pulse width in a second half-cycle of the square wave output voltage waveform immediately following the first half-cycle, is provided such that the square wave power supply provides a pulse having a width corresponding to the upper specification limit."

X. Independent claim 1 of **auxiliary request II** differs from claim 1 of auxiliary request I in that the feature of

"the square wave output voltage waveform having pulse widths, which correspond to an upper specification limit"

has been amended to read

"wherein the square wave power supply calculates a ~~the~~ square wave output voltage waveform having pulse widths, which correspond to an upper specification limit".

Furthermore, the feature

"when a pulse having the upper specification limit cannot be output before a dead zone ..."

has been amended to read

"such that the calculated pulse width is output when the upper specification limit is reached before a dead zone is reached and when a pulse having the upper specification limit cannot be output before a dead zone ...".

XI. Independent claim 1 of **auxiliary request III** differs from claim 1 of auxiliary request II in that the feature

"wherein the square wave power supply calculates a square wave output voltage waveform having pulse widths, which correspond to an upper specification limit"

has been amended to read

"wherein the square wave power supply calculates and sets a square wave output voltage waveform having pulse widths, which correspond to an upper specification limit at about 110% of the commercial power source".

XII. The appellant's relevant submissions are dealt with in the reasons for the decision.

Reasons for the Decision

Main request, inventive step, Article 56 EPC

1. For the reasons set out below, the Board came to the conclusion that the subject-matter of claim 1 of the main request was obvious to the person skilled in the art starting from the disclosure of document D1.

2. Like the present application, document D1 concerns the operation of a square wave power supply (inverter) that provides power to critical loads such as PFC loads when there is a fault in the commercial power supply (line power). Like the present application, document D1 identifies that when there is a fault in the commercial supply, and the system transitions to inverter operation, PFC loads may experience a problematic drop in voltage (see D1, column 11, lines 15 to 26). To prevent this, as set out in D1, column 11, lines 26 to 40, the system controller 50 begins operation of the inverter 56, following transition from line power, using an inverter pulse width which is "at or near the maximum inverter pulse width" and "wider than that normally required to provide the desired steady state output voltage level under normal operating conditions". The inverter pulse width is then gradually reduced until the RMS output voltage level of the inverter is at the desired RMS voltage level, e.g. 120 or 230 volts. As regards the detailed operation of the inverter, document D1 explains in column 10, lines 35 to 37, column 13, lines 33 and 34 and column 14, lines

22 to 24 that there must be a dead space between the switching of the inverter switching devices 70, 71. Such a "dead space" is a well-known requirement for any inverter to avoid both of the switches being on at the same time and thus short-circuiting the source. It is more usually referred to as "dead-time".

3. Document D1 does not disclose to lock the phase of the square wave power supply to that of the commercial power supply, however the Board concurs with the examining division that locking the output of a UPS (uninterruptible power supply) to the frequency and phase of the commercial power supply was part of the common general knowledge of the person skilled in the art. Indeed, the appellant acknowledged this to be the case both in the grounds for appeal (page 9, first paragraph) and in the oral proceedings before the board.

4. Furthermore, the Board concurs with the finding in section 1.6 of the contested decision that it would have been obvious for the skilled person, starting from the disclosure of document D1, to consider locking the phase of the square wave power supply to that of the commercial power source in order to achieve the known benefits of doing so. This could be to avoid disruptions and glitches on transition from the commercial power supply, see document D2, column 2, lines 17 to 21.

5. Furthermore, the Board considers that it would have been self-evident to the skilled person that the commercial power supply may fail at any phase angle of its AC cycle. Hence, when attempting to implement the system of document D1 with the square wave inverter output locked to the phase of the commercial power

supply, the skilled person would have had to make a decision whether the inverter should begin its operation as soon as possible after the failure, possibly emitting only a partial pulse in the first half-cycle before the "dead space" between switching is reached, or whether the inverter operation should be delayed until the next half-cycle in which it is able to emit a pulse "at or near the maximum inverter pulse width" before the "dead space" is reached. Document D1 discloses in column 2, lines 16 to 19 that some loads may fail when power is interrupted for as little as 2 ms, and discloses in lines 34 to 39 that a break in the input voltage signal provided to a PFC load can cause instabilities and oscillations in the PFC power supply. The Board concurs with the the examining division that these indications would lead the person skilled in the art implementing the system of D1 with an output locked to the phase of the commercial power supply towards emitting a partial pulse in the first half-cycle before the "dead space" between switching is reached, rather than waiting to the end of the first half cycle in order to be able to emit a pulse at or near the maximum inverter pulse width. Hence, the Board concurs with the examining division that the reasons set out in paragraphs 1.6, 1.7 and 1.9.2 of the contested decision would lead the skilled person in an obvious way to the first of these options and hence to the subject-matter of claim 1 of the main request.

6. The appellant submitted that the "dead zone" according to the present application was a parameter that was only used in the first half-cycle after a transient condition and was different to the "dead space" of D1. The Board did not find this convincing. It is clear from the explanations on page 14, lines 4 to 6 of the application as filed that the square wave must be

"closed" (i.e. finished) before the dead zone time t54 to t55. In the Board's view, the skilled person would understand this to be the case every time the polarity of the inverter changes, not just in the first half cycle.

7. The appellant also submitted that in addition to improving synchronization of the square wave output voltage to the commercial power source (as discussed above), the claimed invention also led to a reduction in the complexity of the corresponding circuit. However the appellant did not provide any support for this assertion and no reduction in complexity is evident to the Board.

8. Also, the appellant argued that it was important in D1 that the pulse width be immediately increased to a pulse width at or near a maximum pulse width and that this taught away from the use of a partial pulse in the first half cycle. The Board did not find this convincing. Whilst D1 indeed discloses in general to use the maximum pulse width after failure of the commercial power supply, the Board considers that when attempting to synchronise the square wave power supply to the commercial power supply upon failure, the skilled person would immediately realise that it would not always be possible to use that maximum pulse width in the first half cycle after the transition.

9. Hence, the main request is not allowable for lack of inventive step in the sense of Article 56 EPC.

10. In view of this finding, the other issues concerning the main request which were identified in the communication pursuant to Article 15(1) RPBA do not need to be addressed in the decision.

Auxiliary request I - inventive step, Article 56 EPC

11. In paragraph 2 of the reasons for the contested decision, the examining division noted that the applicant had indicated that the auxiliary request (corresponding to present auxiliary request I) merely represented a rewording of the claims of the main request in view of possible objections under Article 123(2) EPC and found that the substance of the independent claims was therefore the same as has been discussed in view of the main request.

12. For the present auxiliary request I, the appellant did not challenge this finding. In their written submissions the appellant merely referred to their respective submissions on novelty and inventive step for the main request (see sections II.2 and II.3 of the statement setting out the grounds of appeal and of the submission of 22 April 2024) and in the oral proceedings they did not make any submissions on auxiliary request I.

13. The Board's findings on inventive step for the main request therefore apply *mutatis mutandis* to auxiliary request I. Hence, auxiliary request I is also not allowable due to a lack of inventive step in the sense of Article 56 EPC.

Auxiliary request II - inventive step, Article 56 EPC

14. The subject-matter of claim 1 of auxiliary request II differs from that of auxiliary request I in that the square wave power supply calculates pulse widths which correspond to an upper specification limit and in the first half-cycle after transition, a pulse of that

width is output if that can be done before the dead zone is reached.

15. The examining division held that the technical differences introduced into claim 1 of auxiliary request II were merely the result of considerations relating to the loads. According to the examining division, auxiliary request II merely imposed an additional maximum voltage constraint that the person skilled in the art would be in a position to implement, on the basis of his common general knowledge.

16. The appellant argued in respect of auxiliary request II that neither of the documents D1 and D2 disclosed the tailoring of an unlocked pulse width in the first half-cycle after a transient condition to the instantaneous needs of loads coupled to the square wave power supply to enable improved synchronization of an output voltage of a square wave power supply to a voltage waveform reference synchronized to a voltage waveform of a commercial power source while an effective output voltage was maintained at the required level. According to the appellant, the pulse width on transition was calculated so as to correspond to an upper specification limit in order to avoid a pulse width, and hence voltage, that would be too high for a smooth transition. The pulse width calculated according to claim 1 was a more moderate pulse width than the full pulse width that was taught by document D1. This allowed for a fine-tuning according to an upper specification limit.

17. The Board concurs with the examining division's findings. It has to be considered a matter of routine design when implementing any power supply to adapt the output to the constraints of the loads being supplied.

If the loads have some upper (voltage) specification limit, the Board considers that it would be obvious for the skilled person implementing D1 to calculate and set the maximum pulse width according to that upper specification limit, in order to avoid providing the load with a voltage that is greater than that allowed by its specification.

18. Considering the appellant's arguments, it has to be recalled that D1 does not in fact disclose to emit exclusively the maximum pulse width (and hence voltage level) on transition. On the contrary, at column 7, lines 47 to 50 D1 explains that the term "maximum output voltage level" used therein also includes voltage levels which are approximately maximum. Furthermore, in the embodiment (column 11, lines 26 to 33), D1 discloses to use an inverter pulse width which is "at or near the maximum inverter pulse width" on transition and suggests a pulse width of "at least approximately 7/8ths" of the maximum. Thus, the disclosure of D1 allows for some freedom in the setting of the pulse width on transition. If confronted with a load having a (voltage) specification limit, it would be a straight forward matter for the skilled person to use this freedom to set a pulse width which ensures the specification limit is not exceeded.

19. For these reasons the Board finds that auxiliary request II does not meet the requirement for inventive step in the sense of Article 56 EPC.

Auxiliary request III - inventive step, Article 56 EPC

20. According to auxiliary request III, the square wave power supply not only calculates but also sets pulse widths corresponding to the upper specification limit,

and the upper specification limit is at about 110% of the commercial power source.

21. The appellant submitted that with these features the output was optimized to a specific level to meet the needs of average loads coupled to the square wave power supply, whereby the complexity of the method was reduced in terms of both computation and implementation.

22. These arguments failed to convince the board that the claimed combination of features was not obvious. Document D1 already discloses setting the initial pulse width after transition, so to do so at a certain level calculated to take account of a specification would be obvious for the reasons given above for auxiliary request II. Furthermore, an upper specification limit of about 110% of the commercial power source, is an entirely normal specification limit for a load that is to be connected to the commercial power source.

23. For these reasons the Board finds that auxiliary request III does not meet the requirement for inventive step in the sense of Article 56 EPC.

Conclusion

24. In the absence of a request which meets the requirements of the convention, the appeal had to be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

U. Bultmann R. Lord

Decision electronically authenticated