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Datasheet for the decision of 10 January 2017

Case Number: T 0587/11 - 3.5.02

Application Number: 05425827.2

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Language of the proceedings: EN

Title of invention:
A LED driving arrangement

Patent Proprietor:
OSRAM GmbH
OSRAM S.P.A. - SOCIETA' RIUNITE OSRAM EDISON CLERICI

Opponent:
Tridonic GmbH & Co KG

Relevant legal provisions:
EPC Art. 83, 56

Keyword:
Sufficiency of disclosure - (yes)
Inventive step - (yes)

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Case Number: T 0587/11 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 10 January 2017

Appellant: (Opponent)	Tridonic GmbH & Co KG Färbergasse 15 6851 Dornbirn (AT)
Representative:	Rupp, Christian Mitscherlich PartmbB Patent- und Rechtsanwälte Sonnenstraße 33 80331 München (DE)
Respondent: (Patent Proprietor 1)	OSRAM GmbH Marcel-Breuer-Strasse 6 80807 München (DE)
Respondent: (Patent Proprietor 2)	OSRAM S.P.A. - SOCIETA' RIUNITE OSRAM EDISON CLERICI Viale dell'Innovazione, 3 20126 Milano (IT)
Representative:	Bosotti, Luciano Buzzi, Notaro & Antonielli d'Oulx Via Maria Vittoria, 18 10123 Torino (IT)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 4 January 2011 concerning maintenance of the European Patent No. 1791399 in amended form.**

Composition of the Board:

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

Summary of Facts and Submissions

I. The opponent appealed against the interlocutory decision of the opposition division on European Patent EP 1 791 399. The proprietors of the patent are respondents to the appeal.

The contested decision considered the patent proprietors' main request and first to third auxiliary requests, all of which were filed with a letter dated 5 November 2010.

The opposition division held that claim 1 of the main request met the requirements of Article 100(b) EPC but did not involve an inventive step (Article 56 EPC) in view of document D8 in combination with document D12 (see document list below).

Considering the first auxiliary request, the opposition division held that, account being taken of the amendments made, the patent and the invention to which it related met the requirements of the EPC.

II. Including the feature references a) to j) as used by the parties, claim 1 of the first auxiliary request filed before the opposition division with the letter dated 5 November 2010 reads as follows:

a) *A power-supply arrangement for driving at least one LED, including:*

b) *- a transformer (18) having a secondary winding (18b) for driving said at least one LED and a primary winding (18a),*

c) *- a half-bridge arrangement (16) to be fed with an input voltage (IV) and coupled to said transformer (18),*

d) *- a resonant circuit (C1, C2, Lu1; C1, C2, LD1) between said half-bridge arrangement (16) and the primary winding (18a) of said transformer (18), said resonant circuit having a resonance frequency (fr), and*

e) *- a controller (20) configured for switching (22a, 22b) said half-bridge arrangement (16) with a switching frequency variable between at least one first value (f1) and at least one second value (f2), wherein said second value (f2) is closer than said first value (f1) to said resonance frequency (fr) thus producing a boosting effect of the voltage fed towards said at least one LED via said transformer (18).[sic]*

f) *wherein said half-bridge arrangement (16) includes at least one capacitor (C1, C2) to create said resonant circuit as a parallel resonant circuit together with the magnetising (Lu1) and leakage (LD1) inductance of said transformer,*

g) *wherein said input voltage (IV) is an alternating voltage having zero-crossing areas,*

h) *wherein said controller (20) is configured for switching (22a, 22b) said half-bridge arrangement (16) with a switching frequency with said at least one second value (f2) when said input voltage (IV) is in said zero-crossing areas,*

i) *wherein said input voltage is a sinusoidal voltage, and*

j) *wherein said controller (20) is configured for using said input voltage (IV) as a modulating entity of said switching frequency."*

The remaining claims 2 to 11 of the first auxiliary request are all dependant on claim 1.

III. The following documents have been relied upon in the appeal proceedings:

D4: Steigerwald, "A Comparison of Half-Bridge Resonant Converter Topologies" IEEE Transactions on Power Electronics, Vol. 3, No. 2, April 1988

D7: Mohan et al, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 1995, Pages 252-270 (excerpts)

D8: Datasheet, "High Voltage Resonant Controller" for L6598 from ST, February 2002

D12: EP 0 677 982 B1

D19: WO 2006/038157 A2

D20: US 6 344 979 B1

IV. After considering the parties' initial written submissions (notice of appeal dated 3 March 2011, statement of grounds of appeal dated 3 May 2011, response to the appeal dated 12 September 2011, appellant's further letter dated 22 March 2012 and respondents' further letter dated 17 July 2012), the Board of Appeal summoned the parties to attend oral proceedings, setting out their preliminary observations in a communication pursuant to Article 15(1) RPBA annexed to the summons.

The appellant replied to the Board's preliminary observations with a letter dated 7 November 2016.

V. Oral proceedings were held before the Board on 10 January 2017 and the parties submitted the following final requests:

The appellant (opponent) requested that the decision under appeal be set aside and that the European patent be revoked.

The respondents (patent proprietors) requested that the appeal be dismissed (main request), or if that is not possible, that the decision under appeal be set aside and the patent be maintained in amended form on the basis of the claims of either of the second or third auxiliary requests, both filed with the letter dated 5 November 2010.

After having heard the parties and after deliberation the Board came to the conclusion that claim 1 of the respondents' main request (i.e. claim 1 of the first auxiliary request filed before the opposition division with the letter dated 5 November 2010, hereinafter "claim 1") met the requirements of Article 83 EPC and involved an inventive step and pronounced the present decision.

VI. The appellant argued under Article 83 EPC that the patent as amended did not disclose the invention in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art. The various points raised are dealt with in detail in the reasons for the decision.

Furthermore, the appellant argued that the subject-matter of claim 1 did not involve an inventive step, Article 56 EPC, having regard to the prior art,

starting from document D8 and taking into account document D12.

VII. The respondents refuted the appellant's objections.

Reasons for the Decision

1. The appeal is admissible.

2. ***Respondents' main request: Article 83 EPC***

2.1 *Parallel resonant circuit*

The appellant argued that the circuit arrangement disclosed in the patent is not a "parallel resonant circuit" as required by feature **f** of claim 1 and cited documents D4, D7 and D20 to demonstrate what the skilled person would understand by parallel and series resonant circuits.

The Board considers that the patent does disclose an example of how to carry out the claimed "parallel resonant circuit". In the circuit as shown in figure 1 of the patent, when the switch 22a is closed and switch 22b is open, the capacitor C1 is in parallel with, and would resonate with, the transformer magnetising and leakage inductances LD1 and Lu1. Similarly, when the switch 22a is open and switch 22b is closed, the capacitor C2 is in parallel with, and would resonate with, the transformer magnetising and leakage inductances LD1 and Lu1. Figure 2 provides another similar example. The Board can see no clear indication in the documents D4, D7 and D20 as to why the circuit arrangements shown in the patent should not be considered to be a form of parallel resonant circuit.

2.2 *Input voltage having zero-crossing areas*

Considering the features according to which the half-bridge arrangement is "to be fed with an input voltage (IV)" which "is an alternating voltage having zero-crossing areas" (features **c** and **f**), it is noted that claim 1 does not state that the half-bridge arrangement is directly fed with an alternating input voltage. Moreover, the Board doubts that a skilled person would seriously consider interpreting the claim in that way. The patent discloses an arrangement (see paragraph [0015] of the patent) in which the half-bridge arrangement is fed with the alternating input voltage (IV) indirectly via a bridge rectifier 14 and the Board finds it plausible that the skilled person would interpret the claim in line with this arrangement.

2.3 *Input voltage as a modulating entity*

Regarding feature **j**, according to which the controller is configured for using said input voltage as a modulating entity of said switching frequency, the Board notes that according to paragraph [0040] of the patent, in the arrangement of figure 1 "the controller 20 is made sensitive ... to the mains voltage (via the line 20a)". The Board considers that it would be evident to the skilled reader that by sensing the voltage on line 16a (after the rectifier) it is possible for the controller to be sensitive (indirectly) to the mains voltage and hence for it to be able to use the input voltage to modulate the switching frequency.

2.4 *Resonant circuit between the half-bridge arrangement and the primary winding*

The appellant objects that in the patent the resonant circuit cannot be considered as being "between" the half-bridge arrangement and the primary winding of said transformer as claimed, because it includes the capacitors C1, C2 which are part of the half-bridge arrangement and because it includes the inductances which are inherent in the transformer itself. The question to be considered here is whether it is appropriate to construe the term "between" in a limited sense, according to which the resonant circuit is arranged between the half-bridge arrangement and the primary winding and is separate from them both, or whether it is possible and appropriate to construe the term "between" in a more general sense, according to which the resonant circuit is not necessarily a separate entity, but may include features/ characteristics of the half-bridge arrangement and the primary winding. The Board considers that the more general construction is appropriate.

2.5 The objections considered in the preceding paragraphs 2.1 to 2.4 were raised by the appellant before the Board summoned the parties to oral proceedings and the Board set out the essence of the above reasoning in the communication annexed to the summons. The appellant did not challenge these reasons, but raised in the oral proceedings, for the first time, two new objections under Article 83 EPC. These are considered below.

2.6 *Only one capacitor creating the resonant circuit*

2.6.1 The appellant argued for the first time during the oral proceedings that the patent did not sufficiently

disclose how to carry out the invention over the full scope of protection covered by the feature "at least one capacitor" (feature **f**). In particular it was argued that, the patent did not disclose a half-bridge arrangement in which only one capacitor was used together with the transformer inductances to create the parallel resonant circuit and that if one of the capacitors C1, C2 were to be replaced by a wire there would be no resonance and hence no boosting effect as claimed (feature **e**).

2.6.2 The respondents argued that resonant half-bridge circuits with a single capacitor were known in the prior art and part of the common general knowledge of the person skilled in the art.

2.6.3 After hearing the parties' initial arguments it became evident that this new objection raised issues which could not be duly considered without adjournment of the oral proceedings. In particular, it would be necessary to establish what belonged to the common general knowledge of the person skilled in the art regarding circuits with this configuration. For this reason, and because the appellant had not given any convincing reason why this objection had been raised only at this late stage in the procedure, the Board exercised its discretion under Article 13(3) RPBA not to admit this new objection into the proceedings.

2.7 *Asymmetric resonance curve*

2.7.1 The appellant argued that if the frequency response of the parallel resonant circuit was asymmetrical about the resonant frequency, i.e. it had an "asymmetric resonance curve", then the condition specified in feature **e** that the second [frequency] value (f2) is

closer than said first [frequency] value (f1) to said resonance frequency (fr) was not sufficient to guarantee a boosting effect, as claimed in feature **h**, when the half-bridge arrangement was switched at the second frequency value. More particularly, if the first frequency value and the second frequency value were on opposite sides of the resonance frequency, then the shape of the asymmetric resonance curve might be such that the gain at the second frequency value would be lower than the gain at the first frequency value, even though the second frequency value was closer to the resonance frequency than the first frequency value.

2.7.2 The respondents argued that an interpretation of the claim in which the first frequency value and the second frequency value were on opposite sides of the resonance frequency was not what was intended and represented a misinterpretation. In practice it would cause problems if the two frequency values were not on the same side of the resonance frequency curve. Even if, in the exceptional case, the skilled person did want to use first and second frequency values on opposite sides of the resonance frequency and if, in the exceptional case, the frequency curve was such that some choices of second frequency, though closer to the resonance frequency than the first frequency, gave lower gain than the first frequency, then the skilled person would simply not choose these frequencies in order to ensure that there was boosting at the second frequency. Hence, the skilled person would have no difficulty in carrying out the invention.

2.7.3 The Board considered that this new objection could be treated during the oral proceedings without adjournment and admitted it into the proceedings.

2.7.4 The Board considered the respondents' arguments to be persuasive. The fact that particular exceptional circumstances might exist under which the claimed boosting effect might not occur did not de facto lead to the conclusion that the skilled person would be unable to carry out the invention. It was clear to the skilled person, not least from figure 3 of the patent, that the reason behind choosing the second frequency closer to resonance than the first frequency was to obtain a higher gain G2 at the second frequency than the first. Even in the exceptional circumstances described by the appellant the board is convinced that the skilled person would have no difficulty in choosing first and second frequencies so as to obtain a higher gain at the second frequency than at the first and thus to achieve the claimed boosting effect.

2.8 For the reasons set out above, the Board came to the conclusion that claim 1 of the main request meets the requirements of Article 83 EPC.

3. ***Respondents' main request: Article 56 EPC***

3.1 Novelty is not contested.

3.2 Considering inventive step, it is agreed that document D8 can be taken as the closest prior art. Document D8 is a data sheet for the L6598 High Voltage Resonant Controller, a block diagram of which is shown on page 1/16.

3.3 As stated in the description on page 1/16, up to the fourth line of the right column, the L6598 controller is "suited for AC/DC Adapters and wherever a Resonant Topology can be beneficial". According to the fourth and fifth lines, the device "is intended to drive two

Power MOS in the classical Half Bridge Topology", and an example of its use in such an application is shown in figure 22.

3.4 Figure 22 is not described in the text of D8. It is however not contested that the skilled person would derive from figure 22 the following features (references in square brackets refer to claim 1 of the main request):

- The circuit as a whole acts as a power supply, giving a DC output Vo which, although not shown, would be suitable for driving an LED [feature **a**];
- The L6598 controller is arranged to drive two Power MOS transistors in a classical half-bridge (inverter) arrangement [parts of features **c** and **e**];
- The half-bridge arrangement is fed (via a power factor correction circuit including a controller L6561) by a bridge rectifier, which is fed with an 85 to 270 Vac input voltage that would be sinusoidal with zero crossing areas [part of feature **c**, features **g** and **i**];
- The half-bridge arrangement is coupled to a transformer having a primary winding and a secondary winding which would be suitable for driving an LED [feature **b** and the remaining part of feature **c**]; and
- a resonant circuit (having a resonance frequency) exists between the half-bridge arrangement and the primary winding of the transformer, that resonant circuit being formed by the two capacitors of the half-bridge being alternately switched to be in parallel with the various inductances of the transformer and an inductor in series with the primary winding [features **d** and **f**].

3.5 Document D8 furthermore discloses a dedicated timing section that "allows the designer to set a Soft Start Time, Soft Start and Minimum Frequency" (page 1/16, right column, lines 5 to 7). This uses resistors (Rfmin, Rfstart) and capacitors (Cr, Css) connected to pins 1 to 4 of the controller chip (see page 2/16) to set two different "Minimum" and "Soft Start" oscillation (i.e. switching) frequencies (see page 4/16, electrical characteristics: f_{min} 60 kHz typ.; f_{start} 120 kHz typ.). These frequencies amount to first and second frequency values which the controller is configured to switch the half-bridge arrangement with [cf. part of feature **e**].

3.6 The features of claim 1 which remain are that:

- said second value (f2) is closer than said first value (f1) to said resonance frequency (fr) thus producing a boosting effect of the voltage fed towards said at least one LED via said transformer (18) [remaining part of feature **e**],
- said controller (20) is configured for switching (22a, 22b) said half-bridge arrangement (16) with a switching frequency with said at least one second value (f2) when said input voltage (IV) is in said zero-crossing areas [feature **h**], and
- said controller (20) is configured for using said input voltage (IV) as a modulating entity of said switching frequency [feature **j**].

3.7 The appellant argued that in D8 one of the two frequencies would necessarily be closer to the resonance frequency of the resonant circuit than the other and that it is self-evident that a boosting effect would be achieved with the closer frequency.

The Board is not convinced by these arguments. Whilst document D8 discloses a "resonant controller" (see title) and states on page 1/16 that it is "perfectly suited for AC/DC Adapters and wherever a resonant topology can be beneficial" and furthermore discloses in figure 22 an AC/DC adaptor application which includes a resonant circuit, there is no mention of the resonance frequency of that resonant circuit and no mention of how the "Minimum" and "Soft Start" switching frequencies disclosed might relate to that resonance frequency. Thus, they could be equally distant from the resonance frequency, one higher and one lower. Hence, it cannot be directly and unambiguously derived from D8 that one of these two frequencies is closer to the resonance frequency than the other.

3.8 The appellant argued further that the remaining features of claim 1 would be reached in an obvious way by a combination of D8 with D12. The appellant put forward that the L6561 controller shown in figure 22 of document D8 was a separate circuit provided to meet power factor correction (PFC) and electromagnetic interference (EMI) requirements and that for the skilled person seeking to simplify the circuit it would be obvious to integrate that functionality into the L6598 resonant controller driving the half-bridge. According to the appellant, D12 provided the solution to this problem, disclosing to modulate the frequency of the resonant controller to smooth the waveform of the rectified intermediate circuit voltage U_{zk} and reduce unwanted spikes.

3.9 Document D12 discloses a method for operating a ballast for gas discharge lamps. The ballast circuit is fed from an AC line and includes a rectifier 1, a smoothing

capacitor C1 and an inverter 2 which converts the rectified voltage U_{zk} into a high frequency AC voltage and feeds it to a lamp circuit. The lamp circuit is a resonant circuit that includes the gas discharge lamp La (see D12, paragraphs [0015] and [0016]).

As set out in paragraphs [0018] and [0019] of D12 (text taken from the corresponding passages of the related patent US 5 563 477, emphasis added):

"During normal operation of lamp La (i. e. after successful ignition), the inverter frequency fW is given by a function as shown in the diagram of FIG. 2. Therein, $U_{ZK,n}$ denotes the normal average rectified voltage U_{ZK} and $f_{W,n}$ denotes the normal average inverter frequency at this voltage. Control circuit 4 and voltage controlled oscillator VCO 3 are designed such that the normal average inverter frequency $f_{W,n}$ lies close to the resonance frequency of the lamp circuit."

"In a normal voltage range A of the rectified voltage U_{ZK} the inverter frequency f_W is controlled such that it decreases linearly with decreasing rectified voltage U_{ZK}. Since the lamp circuit with burning lamp La presents a substantially inductive load, a decrease of f_W at a given U_{ZK} causes a corresponding increase of the lamp current. When U_{ZK} decreases, the lamp power can therefore be kept constant by increasing the inverter frequency f_W."

From the above-mentioned passages it is evident that the circuit of D12 is specifically designed to operate using the highly inductive characteristics of a discharge lamp to create a resonant circuit. It would be evident to the skilled person that LEDs do not provide such an inductive load and could not create a

resonant circuit in this way. Furthermore, their driving requirements are quite different to those of discharge lamps. For these reasons the Board finds that it would not be obvious for a skilled person, starting from D8 and looking to provide a circuit (suitable) for driving an LED to look for solutions in a document, such as D12, which discloses a circuit designed to operate in close cooperation with a light source having entirely different electrical characteristics. Hence, the submissions of the appellant are moot.

3.10 Furthermore, as the respondent argued, D12 does not disclose or suggest switching the inverter with a switching frequency that is closer to the resonance frequency when the input voltage is in zero-crossing areas. The voltage U_{ZK} used in D12 to control the switching frequency is provided by rectifying the AC input voltage U_{AC} and smoothing using a capacitor C1. There is no suggestion in D12 that the voltage U_{ZK} can be used to indicate the location of the zero-crossing areas of the input voltage and because of the smoothing action of the capacitor, that would not even seem to be possible. Hence, even if the skilled person were *arguendo* to apply the teachings of D12 to D8, there would still be no incentive to switch the inverter with a switching frequency that is closer to the resonance frequency when the input voltage is in zero-crossing areas.

3.11 The appellant had also in his written submissions raised inventive step objections starting from the combination of D8 and D12 and using the teachings of documents designated D23 to D25. However, during the oral proceedings before the Board they indicated that they were not pursuing those objections, but instead relied only on the objection based on D8 and D12, as

discussed above. Those objections are therefore not addressed in this decision.

4. ***Conclusion***

The Board concludes that none of the appellant's objections give cause to set aside the contested decision. Hence the appeal has 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