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Datasheet for the decision of 8 December 2015

Case Number: T 1995/14 - 3.5.02

Application Number: 04769910.3

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Title of invention:
LED Temperature-Dependent Power Supply System and Method

Applicant:
Koninklijke Philips N.V.

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - main request (yes)
Inventive step - ex post facto analysis

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Case Number: T 1995/14 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 8 December 2015

Appellant: (Applicant)
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Decision under appeal:
Decision of the Examining Division of the European Patent Office posted on 13 May 2014 refusing European patent application No. 04769910.3 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman R. Lord
Members: M. Léouffre
R. Cramer

Summary of Facts and Submissions

I. The applicant appealed against the decision of the Examining Division, dispatched on 13 May 2014, to refuse the European patent application No. 04769910.3. The statement setting out the grounds of appeal was received on 16 September 2014.

II. The Examining Division refused the second and third auxiliary requests which were remitted to it following a decision by the present Board of Appeal in a different composition in case T 1983/09.

III. In case T 1983/09 the Board considered that the amendments made at the appeal stage had substantially changed the factual framework of the contested decision, and that an additional search could have been required to determine the relevant prior art (see penultimate paragraph of item 5.1 of that decision).

IV. In the decision under appeal in the present case the Examining Division held that the application did not meet the requirements of Article 56 EPC, having regard to document US 6 400 101 B1 (D5) in combination with the common general knowledge of a skilled person.

V. The appellant requested in writing that the decision under appeal be set aside and that a patent be granted on the basis of a set of claims filed with the statement of grounds of appeal and corresponding to the claims of the former second auxiliary request.

VI. Claim 1 according to the appellant's sole request reads as follows.

"A system (20) for supplying power to an LED load (10), the system (20) comprising:
a LED driver module (30) operable to regulate a flow of a LED current (I_{LED}) through the LED load (10) as a function of a temperature-dependent feedback signal (TDFS); and
a current controller module (60) in electric communication with said LED driver module (30) to communicate the temperature-dependent feedback signal (TDFS) to said LED driver module (10),
wherein said current controller module (60) is operable to generate the temperature-dependent feedback signal (TDFB) as a function of an operating temperature of the LED load (10) and the flow of the LED current (I_{LED}) through the LED load (10), and
wherein said current controller module (600) includes:
means for generating a temperature feedback signal (V_{TF}) as a function of a sensed operating temperature of the LED load (10);
wherein the temperature feedback signal is a temperature feedback voltage (V_{TF}) and said current controller module (600) includes: a first operational amplifier (U1) operable to generate the temperature feedback voltage (VTF) as a function of the operating temperature of the LED load (10);
means for generating a current feedback signal (V_{CF}) as a function of a sensed flow of the LED current (I_{LED}) through the LED load (10);
wherein the current feedback signal is a current feedback voltage (V_{CF}) and said current controller module (60) includes: a second operational amplifier (U2) operable to generate the current feedback voltage (V_{CF}) as a function of the flow of the LED current (I_{LED}) through the LED load (10); and

means for mixing the temperature feedback signal (V_{TF}) and the current feedback signal (V_{CF}) to yield the temperature and current-dependent feedback signal (TDFB),
wherein the temperature and current-dependent feedback signal (TDFB) is a feedback voltage generated as a mixture of the temperature feedback voltage (V_{TF}) and the current feedback voltage (V_{CF})."

Claims 2 to 14 are dependent on claim 1.

VII. The appellant's arguments as far as they are relevant for the present decision can be summarised as follows:

The request in this appeal corresponded to the second auxiliary request addressed in the decision under appeal.
Claim 1 involved an inventive step over the disclosure of D5, D6 (US2002/130786 A1) and the alleged, but unproven "knowledge of the skilled person".

In D5, there was no disclosure of the following features which were required by claim 1 :
(i) a means for generating a temperature feedback signal which is a temperature feedback voltage (V_{TF}) generated by a first operational amplifier (U1),
(ii) a means for generating a current feedback signal which is a current feedback voltage (V_{CF}) generated by a second operational amplifier (U2), and
(iii) a means for mixing those signals to yield a temperature and current-dependent feedback signal (TDFB) which is a feedback voltage generated as a mixture of the temperature feedback voltage (VTF) and the current feedback voltage (VCF).

In the decision in case T 1983/09 the Board of Appeal held that D5 did not objectively disclose features (i) and (ii) identified above. The Board also stated that "D5 is indeed silent about the type of signal generated by the temperature regulation means and about the adder connected to the inverting input of the regulation means". Thus, according to the Board, D5 did not objectively disclose a temperature feedback voltage, so that feature (iii), which mentioned such a "temperature feedback voltage", was not disclosed either.

In paragraph 3.1.2 of the contested decision the Examining Division agreed that features (i) and (ii) were not disclosed in D5, but concluded, as stated in paragraph 3.2.2 and 3.2.3 of the decision that feature (iii) was disclosed in D5. This conclusion was not correct and contrary to the findings of fact stated by the Board of Appeal in the Reasons for the Decision in the case T 1983/09.

By providing these features in combination with the remaining features recited in claim 1, the claimed system provided a simple current controller module which provided a continuous feedback control of the LED as a function of both the sensed operating temperature of the LED load and the LED current through the LED load. In particular, it provided continuous control (page 11 , line 31 to page 12, line 6 of the original specification) over a wide temperature range. The two operational amplifiers operated independently to generate the respective voltage signals, which were then mixed. The use of the two operational amplifiers provided substantially aligned current and temperature control, and enabled the system to respond rapidly to current and temperature fluctuations.

As shown in Figure 3 of the present specification, the LED load was continuously controlled over a wide temperature range, based on the selection of a respective operational relationship between the resistive value of the LED load operating temperature sensor and the current through the LED load.

This technical effect of continuous control of current supplied to a LED driver with respect to temperature over an operating temperature range, in particular over a wide temperature range, had application, for example, in LED luminaires providing high quality light of a desired tuned colour temperature.

The objective technical problem starting from D5 was to provide a more simplified responsive feedback control of the power supply to the LED load so as to provide a temperature dependent control of the current supplied to the LED which could be continuous control of current supplied dependent on temperature over the operating temperature range.

The purpose of the circuitry of D5 on the other hand was primarily to prevent the LED from destruction resulting from an increased ambient temperature. Figure 3 of D5 showed the relationship between the forward current of the LED and ambient temperature. The current was constant up to an ambient temperature of 70°C and then was linearly reduced up to a maximum ambient temperature of 100°C, at which temperature the forward current of the LED was switched off. There was no disclosure or hint in D5 to solve the problem of providing a temperature dependent control of the current supplied to the LED as a continuous control of current supplied dependent on temperature over the operating temperature range.

Referring to paragraph 3.1.4 of the contested decision, even though operational amplifiers might have been known generally, there was no hint to the skilled person in D5 or D6, or in the common general knowledge, to somehow introduce two respective operational amplifiers into the circuit of Figure 8 of D5 in the specific manner recited in claim 1 and to process the specific respective signals recited in claim 1 in order to solve the correctly formulated objective technical problem. Moreover, no evidence of the common general knowledge had been provided.

The examining division relied upon D6 to assert that the skilled person, starting from D5, would "always consider the use of operational amplifiers for processing the measured signals". This unsubstantiated assertion indicated that the Examining Division had wrongly used hindsight in their analysis of inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. In accordance with the analysis of the content of D5 in case T 1983/09 the Board considers that document D5 discloses a system for supplying power to an LED load (cf. column 5, line 51 and figure 8) e.g. traffic lights (cf. column 4, lines 33 and 34), the system comprising:
a LED driver module (comparator and transistor T) operable to regulate a flow of a LED current I_{LED}

through the LED load as a function of a temperature-dependent feedback signal U_{REG} (cf. figure 8 and column 7, lines 13 to 27); and
a current controller module (Regulator) in electric communication with said LED driver module to communicate the temperature-dependent feedback signal U_{REG} to said LED driver module.
The current controller module is operable to generate a temperature-dependent feedback signal U_{REG} in response to an operating temperature (signal input to the adder connected to the inverting input of the regulator) and the flow of the LED current through the LED load (signal at the non-inverting input of the regulator).
The current controller module includes means for generating a temperature feedback signal as a function of a sensed operating temperature of the LED load (see column 4, lines 18 to 21 and column 7, lines 13 to 16 and figure 8: NTC and temperature regulation module) and means for generating a current feedback signal as a function of a sensed flow of the LED current I_{LED} through the LED load (cf. column 2, lines 57 to 62).
The current feedback signal is a current feedback voltage (output of the integrator is necessarily a voltage since it is applied to an input of an operational amplifier used as a regulator).
The system further comprises means for mixing the temperature feedback signal and the current feedback voltage (see figure 8: adder at the input of the regulator and the regulator drawn as an operational amplifier) to yield a temperature and current—dependent feedback voltage U_{REG}.

Hence the system of claim 1 differs from that of D5 at least in that:
- the temperature feedback signal is a temperature feedback voltage, and

- the current controller module includes a first operational amplifier (U1) operable to generate the temperature feedback voltage (VTF) as a function of the operating temperature of the LED load (10), and
- a second operational amplifier (U2) operable to generate the current feedback voltage (V_{CF}) as a function of the flow of the LED current through the LED load (10).

3. D5 is silent about the type of signal generated by the temperature regulation means and about the implementation of the adder connected to the inverting input of the regulator. A straightforward solution for a person skilled in the art would be to generate and apply a current as a temperature sensing signal to the middle tap of the resistive divider (R_i and R_{ext} on figure 8), modifying thereby the voltage applied to the inverting input of the operational amplifier used as the regulator. Mixing currents is always easier than mixing voltages.
Nevertheless a person skilled in the art knows how to mix voltages. The regulator means of D5 is an example of a circuit based on an operational amplifier to mix voltages representing a feedback current sensing signal and a temperature and current-reference information.

The Board therefore considers that it would in principle have been obvious to a person skilled in the art to implement the mixing function of D5 by providing a voltage as a temperature feedback signal to a first input of a first operational amplifier while the second input of that first operational amplifier would have been connected to the middle tap of the voltage divider. The two voltages would have thus been mixed by this first operational amplifier and provided as a voltage signal to the inverting input of the regulator.

This voltage signal would have resulted from a comparison of the temperature signal with a reference value, which would have remained a current reference value. However, the purpose of the circuit of D5 is to protect the LED load against overheating according to the limits shown in figure 3 (see also column 4, lines 10 to 28). A simple comparator circuit built around a first operational amplifier in the manner discussed above would not have enabled those limits to be implemented. Hence the Board considers that the insertion of a first operational amplifier in lieu of the adder would not have been an obvious solution of the problem of how to implement the adder of D5.

The Board therefore sees no reason why a skilled person would have departed from the simple implementation of D5 wherein a temperature feedback signal as a current is applied to the middle tap of a current reference signal to modify the latter, for the more complex (and hence costly) solution now claimed.

4. Furthermore, even if the skilled person were to consider implementing the mixer of D5 using an operational amplifier, which would correspond to the first operational amplifier of the present claim 1, in order to arrive at a system as claimed it would still be necessary to provide also the second operational amplifier. There are two ways in which this could be envisaged, which are addressed separately below.

The first is that the regulator of the circuit shown in figure 8 of D5 could be seen as comprising an operational amplifier. However, in the opinion of the Board this operational amplifier cannot be seen as corresponding to the second operational amplifier recited in claim 1 because it generates neither a current feedback voltage nor a feedback voltage as a function of the flow of the LED current through the LED load. The term "function" in the claim should not indeed be understood as defining any arbitrary kind of relationship between the response of the operational amplifier and its inputs. The operational amplifier used as a regulator and shown in figure 8 of D5 delivers a kind of square waveform while the term "function" as used in claim 1 would rather be understood by a skilled person as defining a continuous function whereby the output of the operational amplifier is constantly modified as a function of the inputs. This interpretation is confirmed by the embodiments of the invention shown in figures 2 and 6 of the application which make use of the second amplifier U2 as a linear amplifier.

The regulator of D5 provides a voltage signal resulting from the comparison between the voltage representing the current flowing through the LED load and the compound signal representing the current setting value modified by the temperature signal value. Thus, even if a person skilled in the art were to implement the adder of figure 8 with a first operational amplifier as recited above, the regulator of D5 would not produce a voltage as a function of the flow of the LED current through the LED load, i.e. a value constantly modified as a function of the modified current flowing in the LED load, but rather a square-wave voltage resulting from the comparison between the voltage representing the current flowing in the LED load and a compound signal value resulting from mixing a reference value and a temperature signal value. This is a consequence of the fact that the purpose of D5 is to protect the LED load against overheating according to the limits shown in figure 3 (see also column 4, lines 10 to 28).

The second possible manner in which a second operational amplifier might be incorporated in D5 would be to use it as part of the integrator. However, on the one hand, this would not have changed the fact that the regulator would not have delivered a voltage as a function of the flow of the LED current through the LED load for the reasons mentioned before, and on the other hand, there is no hint in D5 for a person skilled in the art to replace the simple integrator, which delivers a mean current value, with a more complicated circuit built around an operational amplifier inserted between the current measuring resistance R_{shunt} and the regulator shown in figure 8, for delivering a current value constantly varying with the variations of the current flowing through the LED load.

5. Thus it can be seen that the system according to the invention provides in a non-obvious manner the advantage of setting an operating point which can continuously vary with the continuous variations of the current flowing through the LED load and the temperature of the LED load, in contrast to the system of D5, which merely protects the LED load against overheating.

6. The board is also of the opinion that the document D6 cited in the decision under appeal is not relevant in this respect, because the amplifier 124 shown in figure 1 of D6 is just an example showing that an amplifier can be used to receive a temperature signal. D6 does not teach that a person skilled in the art would always treat a temperature signal with an amplifier. Hence D6 does not help showing that a person skilled in the art would have inserted an operational amplifier in lieu of the adder shown in figure 8 of D5. The Board is

therefore of the opinion that the conclusion of the Examining Division that a person skilled in the art would modify the circuit shown in figure 8 of D5 in such a way as to arrive at a system according to the present claim 1 results from the application of hindsight.

7. The subject-matter of claim 1 of the sole request is therefore new and involves an inventive step in the light of the available prior art represented by D5 taken alone or in combination with D6. The conditions resulting from Article 54 and 56 EPC are therefore met.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent with the following claims and a description to be adapted:

   Claims:
   Nos. 1 to 14 as filed with the letter of
   16 September 2014.

The Registrar: The Chairman:

U. Bultmann R. Lord

Decision electronically authenticated