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Datasheet for the decision of 6 February 2015

Case Number: T 1884/10 - 3.5.02

Application Number: 03813686.7

Publication Number: 1579735

IPC: H05B33/08

Language of the proceedings: EN

Title of invention:
LEDs driver

Applicant:
Koninklijke Philips N.V.

Headword:

Relevant legal provisions:
EPC Art. 83, 84, 123(2), 54, 56

Keyword:
Sufficiency of disclosure - (yes)
Claims - clarity after amendment (yes)
Inventive step - non-obvious modification

Decisions cited:

Catchword:

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Case Number: T 1884/10 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 6 February 2015

Appellant: (Applicant)	Koninklijke Philips N.V. High Tech Campus 5 5656 AE Eindhoven (NL)
Representative:	Damen, Daniel Martijn Philips Intellectual Property & Standards P.O. Box 220 5600 AE Eindhoven (NL)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 25 February 2010 refusing European patent application No. 03813686.7 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	M. Ruggiu
Members:	M. Léouffre
	W. Ungler

Summary of Facts and Submissions

I. The applicant appealed against the decision of the examining division, posted on 25 February 2010, to refuse European patent application No. 03 813 686.7.

II. The examining division held that the subject-matter of claim 1 of the main request, then on file, lacked clarity (Article 84 EPC) and that the application did not meet the requirements following from Article 83 EPC.

III. With the statement setting out the grounds of appeal, received on 7 July 2010, the appellant filed new claims 1 and 13.

IV. In an annex to the summons to oral proceedings dated 29 October 2014, the Board indicated that the application could be seen as not complying with the requirements following from Articles 83, 84 and 123(2) EPC.
The Board referred also to the cited prior art, in particular to document
D4 : Datasheet "LT1932 - Constant-Current DC/DC Led Driver in ThinSot", 2001, Linear Technology (XP002274447).

V. Oral proceedings in front of the Board took place as scheduled on 6 February 2015.

VI. During the oral proceedings the appellant requested that the decision under appeal be set aside and that a patent be granted in the following version:
Claims 1 to 10 as filed during the oral proceedings of 6 February 2015;
Description: pages 1, 1a, 2 to 9 as filed during the oral proceedings of 6 February 2015;

Drawings: 1/4 to 4/4 as filed during the oral proceedings of 6 February 2015.

VII. Claim 1 reads as follows:

"A power supply (20) for a LED light source (10), said power supply (20) comprising:

a power converter (23) to provide a regulated power including a LED current and a LED voltage to the LED light source (10);

an LED current sensor (25, Rl) arranged to provide a sensed current indicative of a magnitude of the LED current flowing through the LED light source (10);

a feedback controller (27, 125), wherein the LED current sensor (25, Rl) is arranged to feed the sensed current to the feedback controller (27, 125), and the feedback controller (27, 125) is arranged to provide a feedback signal to the power converter (23), in order to control the LED current included in the regulated power that is provided by the power converter (23) to the LED source (10, 110);

a LED control switch (24) to control a flow of the LED current through the LED light source (10), wherein said LED control switch (24) includes a first switch (SW1) and a second switch (SW2), the first switch (SW1) establishing a current path from the LED light source (10) to said power converter (23) when the LED current is below a peak threshold; and

a LED PWM dimmer (29) to provide a pulse width modulation signal to said first switch (SW1) in response to an external dim command to thereby dim the light source (10);

characterized in that:

the LED current sensor (25, Rl) is arranged to provide the sensed current to both the feedback controller (27, 125) and the second switch (SW2), and in addition to the sensed current being used to provide

said feedback signal in order to control the LED current included in said regulated power, the second switch (SW2) is arranged to operate the first switch (SW1) to turn off when the second switch (SW2) is turned on and thereby limit the peak of the LED current to a safe level when the sensed LED current exceeds the peak threshold upon the LED light source (10) being connected to the power supply (20) subsequent to an energizing of the power supply."

Claims 2 to 10 are dependent on claim 1.

VIII. The appellant argued essentially as follows:

The claimed power supply was a stand alone device to which LEDs might be connected. The problem of connecting LEDs to an energised power supply and its solution were recited in page 1 of the original description. Allowing the LED light source (10) to be connected to the power supply subsequent to an energizing of the power supply only implied that two connectors were available between the LEDs and the power supply shown in figure 2.
Claim 1 was based on original claim 1 which mentioned "initial loading" and page 3, lines 13 to 16 wherein the feature "initial loading" was defined as meaning "adding a load".

The circuit disclosed in D4 was used for hand-held computers and similar devices as mentioned in the right column of page 1. The power supply of D4 could not be used as a stand alone supply. The problem of connection of a LED subsequent to the connection of the power supply was not mentioned in D4, and D4 did not comprise any teaching about plugging-in a LED in an already energised power supply. The regulating loop shown in

figure 1 of D4 was not able to regulate the current during initial loading, and neither the switch Q2 nor the comparators A1 and A2 shown therein comprised a second switch in the sense of the application. Switch Q2 and the possible second switches provided in amplifiers A1 or A2 belonged to the feedback regulating loop. The claimed power supply differed from the circuit of D4 in that it had three main features, namely a regulator, a PWM dimmer and a second switch. The Zener diode shown in figure 4 of D4 rather protected the LEDs against over-voltage than against over-current and should not be seen as a second switch in the sense of the application. The overcurrent protection circuit disclosed in figure 7 of D4 did not protect the LEDs against overcurrent following a reconnection of the LEDs to an already energised power supply either. It only protected the LEDs against the overcurrent following the first power-on of the power supply. It did also not act as a protection against an overcurrent at a level higher than the peak threshold of the regulated current either.

Reasons for the Decision

1. The appeal is admissible.

2. Sufficiency of disclosure (Article 83 EPC)

2.1 The examining division objected that it would not be possible for a person skilled in the art to clearly understand whether the switch SW1 shown in figure 2 was operated in an ON/OFF manner or in a linear manner (cf. item 7 of the reasons for the decision). The person skilled in the art would therefore lack sufficient and unambiguous information to implement an essential part of the invention.

2.2 The paragraph bridging pages 5 and 6 of the original published description could mean that the NPN transistor SW2 would be operated in the saturation mode i. e. it would be either totally turned off or completely turned on. When the switch SW2 is turned on, its collector emitter voltage may be close to zero. Consequently the gate voltage of MOSFET SW1, which is drawn as an N-channel JFET, may be lower than its source voltage. The drain-source current of an N-channel JFET is reduced by lowering the gate voltage with respect to the source voltage up to the "pinch-off" voltage at which the MOS-FET transistor is in a non-conducting state. Hence, when the NPN transistor SW2 is turned on, the LED current might be reduced to a safe level or completely suppressed.

The mode of operation of the switch 127, i.e. switches SW1 and SW2 taken together, depends on the transistor characteristics and on different values of voltage, current and resistor R1, which are not given in the application. The Board considers however that the determination of an appropriate operating point at which "the second switch (SW2) is arranged to operate the first switch (SW1) to turn off when the second switch (SW2) is turned on and thereby limit the peak of the LED current to a safe level when the sensed LED current exceeds the peak threshold" is a normal practice for a man skilled in the art. The application is therefore considered as complying with the requirements following from Article 83 EPC.

3. Admissibility of new claim 1

Claim 1 is based on original claim 1 wherein the expression "initial loading" has been replaced by its

definition found at page 3, lines 15 and 16: "a connection of LED light source 10 to power supply 20 subsequent to an energizing of the power supply". The feature that "the LED current sensor (25, Rl) is arranged to provide the sensed current to both the feedback controller (27, 125) and the second switch (SW2)" is unambiguously derivable from figure 2, and the other features of claim 1 may be found in page 3, lines 3 to 10, page 4, lines 11 and 12, as well as in the paragraph bridging pages 5 and 6 and in original claim 2. Actually the following expression found in original claim 2 "to eradicate a current path", which had been objected as unclear by the examining division, has been suppressed and replaced by the feature that "the second switch (SW2) is turned on and thereby limit the peak of the LED current to a safe level when the sensed LED current exceeds the peak threshold", which is based on pages 5 and 6, in particular page 5, lines 30 to 32 and page 6, lines 1 and 2 of the original published description.
The subject-matter of claim 1 is therefore clear and complies with the requirements following from Article 123(2) EPC as it does not extend beyond the content of the application as filed.
Claims 2 to 10 are based on original claims 3 to 11.

Claims 1 to 10 complying with the requirements following from Articles 84 and 123(2) EPC and no new issues being raised by the said claims, the Board exercising its discretionary power according to Article 13 RPBA decided to admit the new claims into the proceedings.

4. *Novelty and inventive step (Articles 54 and 56 EPC)*

4.1 The aim of the present invention is to protect the LEDs upon connection to a power supply already connected to the network. Actually the power converter of a power supply according to the invention may have at least one capacitance which becomes charged when the power is turned on without a load. When a load (i.e. the LED light source) is subsequently connected, without further measures being taken, this charge would discharge through the light source causing a current surge which could damage the LEDs (cf. page 3, paragraph 5 of the letter dated 2 January 2015). In the embodiment of the invention, the capacitance is constituted by capacitors C2 and C3 which get charged over transformer 123 and discharge through the newly connected load 110 and the first switch SW1 to ground.

4.2 This effect and its drawback have been acknowledged in D4 (cf. section "open circuit protection" and figure 4 in page 7); the LED power supply disclosed therein is therefore considered as the closest available prior art.
D4 shows in figure 1 a power supply for a LED light source comprising a power converter (L1, C1 and Q1) providing a regulated power including a LED current and a LED voltage to the LED light source. The power supply comprises further an LED current sensor providing a sensed current indicative of a magnitude of the LED current flowing through the LED light source. The sensed current value is fed to a feedback controller (A1, A2, SR latch and Q1-driver) arranged to provide a feedback signal to the power converter (cf. bottom of right column of page 4) in order to control the LED current included in the regulated power that is provided by the power converter to the LED source.
The power supply comprises also a switch Q2 establishing a current path from the LED light source

to said power converter to control a flow of the LED current through the LED light source when the LED current is below a peak threshold, i. e. in normal operating conditions.
The power supply of D4 comprises further a LED PWM dimmer to provide a pulse width modulation signal to said transistor switch Q2 in response to an external dim command PWM (cf. the section "Dimming using a PWM signal" on page 7, and Figure 6 on page 8, especially the second diagram from the left).

Switch Q2 of D4 is controlled via the driver and the amplifier A1 so as to limit the peak of the LED current (see D4, page 4, Figure 1 and the section "Operation"). During a first power-on the current may also be clamped using the soft-start circuit shown in figure 7 and described on page 8 under "Soft-Start/Controlling Inrush Current".

The current sensed by the sense resistor is provided only to amplifier A1. The amplifier might be seen as comprising a second transistor which operates the first switch Q2. This second switch would however be part of the feedback controller.

4.3 Hence, the subject-matter of claim 1 differs from the power supply disclosed in D4 in that

the LED current sensor (25, Rl) is arranged to provide the sensed current to both the feedback controller (27, 125) and the second switch (SW2), and in addition to the sensed current being used to provide said feedback signal in order to control the LED current included in said regulated power, the second switch (SW2) is arranged to operate the first switch (SW1) to turn off when the second switch (SW2) is turned on and thereby limit the peak of the LED current

to a safe level when the sensed LED current exceeds the peak threshold upon the LED light source (10) being connected to the power supply (20) subsequent to an energizing of the power supply.

The subject-matter of claim 1 is therefore new (Article 54 EPC).

5. Inventive step (Article 56 EPC)

5.1 The aim of the present invention is to protect the LEDs upon connection to an (already) energised power supply. Therefore the invention is characterised in that "the LED current sensor (25, Rl) is arranged to provide the sensed current to both the feedback controller (27, 125) and the second switch (SW2)". Two different current regulating loops are thereby defined. The first loop involves the feedback controller and aims at regulating the current during normal operating conditions, i. e. up to a peak current threshold. The second loop comprises the second switch. The second loop is active "when the sensed LED current exceeds the peak threshold" which happens essentially "upon the LED light source (10) being connected to the power supply (20) subsequent to an energizing of the power supply".

5.2 The first switch SW1 is ON/OFF controlled by the PWM dimmer. During the ON-times, and without further measures being taken, an overcurrent due to unloading capacitances C2 and C3 would be limited only by the sense resistor R1, at least until the regulating loop comprising the feedback controller becomes active. The LEDs might have up to then to sustain a current much higher than their rated current.

5.3 According to the invention, a second maximum current is regulated by a second loop and limited to a safe level with the help of a second switch operating the first switch and receiving as a control value the current value sensed at the resistor R1.

For example, the circuit of the embodiment of the invention shown in figure 2 is operated as follows: Assuming the resistor R1 is chosen such that, for a value of a sensed current above the peak threshold value the switch SW2 is driven in the conducting state, the gate voltage of the MOSFET may be lowered down to a point corresponding to the pinched-off state of the MOSFET limiting thereby the LED current to a current value which is safe for the connected LEDs. Indeed, when the NPN transistor is conducting, the gate voltage becomes lower than the source voltage and the reduced MOS-FET channel conducts less current. To the current limiting resistor R1, the present invention adds the channel resistance of MOSFET switch SW1 protecting thereby the LEDs as long as a current flowing through the LEDs is higher than the peak threshold.

5.4 The invention limits the overcurrent further than the open-circuit protection of D4 (cf. figure 4) and the soft-start circuit of D4 (cf. figure 7) do.
The open-circuit protection of D4 ensures that the regulating loop is active when the LEDs are connected. It does not provide a second protecting current controlling loop. Actually the Zener diode conducts when the LED strings are disconnected in order to provide a feedback current to the LED pin and initiate the current regulating loop. The Zener voltage being higher than the maximum forward voltage of the LED strings, when the LED strings are connected, a possible

charge would be flowing entirely through the LED strings and would not be limited to a safe level. The soft-start circuit of D4 (figure 7) does not help either, limiting the overcurrent to a safe level when the LED strings are reconnected. Actually upon an initial power-up of the power supply, capacitance C3 of D4 is charging and any overcurrent is led over transistor Q1, ensuring a soft-start. Capacitance C3 remains however loaded as long as the power supply is connected to the power supply network. A protection against overcurrents occurring upon connection of the LEDs to an energised power supply is not provided with the soft-start circuit of D4.

The second switch SW2 of the invention constitutes a permanent observer of the level of the current flowing through the LEDs. It is particularly useful in case the LEDs are reconnected to an already energised power supply having charged capacitances, whereby for a current level beyond a safe level it operates the first switch SW1 to turn off. Neither the soft-start transistor nor the Zener diode of D4 operates the switch Q2 to limit the overcurrent flowing therein to a safe level.
Thus the subject-matter of claim 1 is not obviously derivable from the available prior art and involves an inventive step (Article 56 EPC).

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 in the following version:
Claims: 1 to 10 as filed during the oral proceedings of 6 February 2015.
Description: pages 1, 1a, 2 to 9 as filed during the oral proceedings of 6 February 2015.
Drawings: 1/4 to 4/4 as filed during the oral proceedings of 6 February 2015.

The Registrar: The Chairman:

C. Vodz M. Ruggiu

Decision electronically authenticated