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(71) Applicants:

- **Osram Gesellschaft mit beschränkter Haftung**
81543 München (DE)
- **OSRAM S.P.A. - SOCIETA' RIUNITE OSRAM**
EDISON CLERICI
20144 Milano (IT)

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(72) Inventors:

- **Scordino, Alessandro**
30170 Mestre (Venezia) (IT)
- **Brieda, Alessandro**
33077 Sacile (Pordenone) (IT)
- **Scilla, Giovanni**
31020 Fontane di Villorba (Treviso) (IT)

(74) Representative: **Schulze, Mark**
Von Lieres Brachmann Schulze
Patentanwälte
Grillparzerstrasse 12A
81675 München (DE)

Remarks:

Amended claims in accordance with Rule 137(2) EPC.

(54) **Circuit and method for driving light emitting diodes**

(57) A LED driver comprises a microcontroller that is adapted to perform at least two of the following functions: LED current regulation; dimming control; thermal management; input power absorption control; input current absorption control; alarms and fault conditions management; and LED light optical feedback.

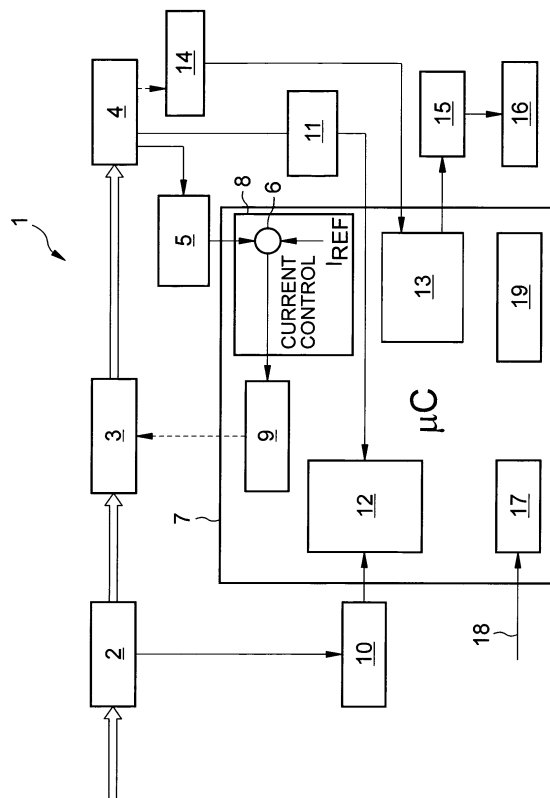


FIG 1

Description

[0001] The invention relates to LED drivers and to a method to drive a LED system, in particular for use with high flux / high power LED systems.

[0002] In high flux / high power LED systems, often several functions / functionalities have to be performed to properly operate the LED system, e. g. to perform a LED current regulation, thermal management etc. Up to date, these functions are implemented using analog circuitry or integrated circuits dedicated to each functionality. The implementation requires a relatively large area on a respective printed circuit board (PCB), adds to the complexity of the system and reduces solution flexibility. Also, bill of materials (BOM) and manufacturing / quality costs are expensive.

[0003] It is thus the object of the present invention to overcome or improve at least some of the above stated problems.

[0004] The object is reached by the LED driver according to claim 1 and the method according to claim 8. Preferred embodiments are especially stated in the dependent claims.

[0005] The LED driver comprises a digital microcontroller that is adapted to perform at least two of the following functions:

- LED current regulation;
- dimming control;
- thermal management;
- input power absorption control;
- input current absorption control;
- alarms and fault conditions management; and
- LED light optical feedback.

[0006] For this, the microcontroller is either programmed accordingly or hardwired, or both. The use of a single microcontroller gives the advantage of only needing a relatively small PCB area and only needing few components (e. g., omitting many auxiliary parts that are typical for an analog solution). Further, a programmable microcontroller achieves a higher flexibility of operation and reduced adaptation costs which is especially advantageously for the use in different platforms including different power ratings, LED source types, dimming requirements etc. Also, a smart management of auxiliary functions (e.g., optimized structure vs. RFI, active thermal management, alarms and fault condition management etc.) is easily implemented. Additionally, a simpler manufacturing and quality assurance can be achieved.

[0007] Advantageously, the LED driver further comprises a connection to a LED current sensor of the overall lighting system and comprises a current converter for converting an input current into an LED (source) current. To drive the converter, the microcontroller comprises a power stage controller. Thus, based on a reading of the LED current sensor, the power stage controller of the microcontroller is enabled to adjust the current converter

to set the LED current. This is advantageously done by implementing the LED control components as a control loop. By using the microcontroller, current levels may be flexibly changed or adjusted on demand.

[0008] Advantageously, the dimming control includes a 3-wire dimming capability. This can be achieved by accessing a special function of the power stage controller of the microprocessor.

[0009] Advantageously, the LED driver further comprises a connection to at least one thermal sensor sensing a temperature related to the LED source(s). The microcontroller comprises a driver circuit for at least one fan. The microcontroller, based on a reading of the thermal sensor(s), is enabled to adjust the operating condition of the fan(s). The temperature sensing design advantageously comprises an analog digital converter device of the microcontroller which advantageously may only need one external resistor divider with a thermistor, for example. Further, only a simple driver circuit for the fan(s) may be implemented. This function may be implemented by dedicated software within the microcontroller.

[0010] Advantageously, the microcontroller, for input power absorption control, comprises at least one analog digital converter to sense an input voltage, an output current, and an output voltage, and the microcontroller setting an input power assuming a statistical efficiency value. The sensing may be performed by the ADC devices of the microcontroller.

[0011] Input current absorption from the power supply is important for a RFI point of view. To improve input current absorption, advantageously, the microcontroller is adapted to perform a sweep of the DC-DC converter switching frequency to spread noise along a wide range instead of a narrow distribution. This sweep may be implemented into the microcontroller by software.

[0012] Advantageously, the alarms and fault conditions management is achieved using interrupts and programming suitable operation logic components.

[0013] In a preferred embodiment, a LED driver further comprises a connection to an optical sensor; wherein the microcontroller in turn comprises a power stage controller such that, based on a reading of the optical sensor, the microcontroller is enabled to drive the power stage controller of the microcontroller in order to adjust an intensity of light emitted from at least one LED.

[0014] The method of driving a LED system is being performed by a microcontroller and comprises at least two of the following steps:

- regulating a LED current;
- controlling a dimming function;
- performing a thermal management;
- controlling an input power absorption;
- controlling an input current absorption;
- performing an alarms and fault conditions management; and
- controlling the light emitted from the LED by means of optical feedback

[0015] The invention is schematically described in more detail in the following exemplary embodiment. Identical or similar components are denoted by the same reference numerals, where applicable.

FIG 1 shows a block scheme diagram of a lighting system comprising a LED driver according to the invention;

FIG 2 shows a schematic diagram of the driver according to the invention;

FIG 3 shows a layout drawing of the driver according to the invention;

FIG 4 shows a plot of RFI results in a first frequency range;

FIG 5 shows a plot of RFI results in a second frequency range; and

FIGs 6-10 show a software embodiment of a LED driver comprising several functions.

[0016] FIG 1 shows a block scheme diagram of components of a lighting system comprising at least parts of a LED driver 1 for three LED sources. At the beginning of the operation of the lighting system (activation), a system input voltage $U = 24\text{ V}$ is applied. to a filter stage 2 after that the input voltage is input into a DC/DC converter 3 that transforms the input voltage of 24 V into a LED current suitable to operate the multiple LED sources 4. The LED current of about 600 mA is sensed by a LED current sense circuitry 5. Subsequently, the sensed current values are transmitted to a comparator 6 of a microcontroller 7. The comparator 6 is part of a current control section 8 of the microcontroller 7.

The comparator 6 compares the LED current with a reference current value I_{REF} . The result of this comparison, e. g. a value for the current difference, is fed back to a power stage controller section 9 of the microcontroller 7 that uses this value to set / drive the DC/DC converter 3 to control the LED current, thus being part of a LED current control loop.

[0017] The LED driver 1 further comprises an input voltage sense circuit 10 fed by the filter stage 2, and an output voltage sense circuit 11 fed by the LED 4. The voltage sense circuits 10,11 are input into a current and power absorption control section 12.

[0018] The microprocessor 7 further, via a thermal control section 13, senses temperature values from the LEDs 4 by means of a temperature sensor 14. The thermal control section 13 further controls a fan driver 14 that in turn drives a fan 15 (e.g., a fan speed) to cool the LED sources 4 to - in turn - adjust their temperature. This can be regarded as a LED source temperature control loop.

[0019] The microcontroller 7 also comprises a dimming control section 17 fed by a dimming input 18 and a

alarms / fault conditions management section 19.

[0020] Additionally, a start-up control may be included (not shown).

[0021] FIG 2 shows a schematic diagram of the LED driver 1 with a relatively small number number of components and a small occupied space. Additionally to a combined filter stage 2 and input voltage sense circuit 10 there is shown the DC/DC converter 3, the LED current sense circuitry 5, the microcontroller 7, the output voltage sense circuit 11, the thermal sense circuitry 14, the fan driver 15, the dimming input 18, LED connections 20, and external connections 21.

[0022] FIG 3 shows a layout drawing of the LED driver 1. In addition to the filter stage 2, the DC/DC converter 3, the LED current sense circuitry 5, the microcontroller 7, the input voltage sense circuit 10 the output voltage sense circuit 11, the thermal sense circuitry 14, the fan driver 15, and the dimming input 18, there are shown receiving areas 22 for the LEDs. This layout is very compact due to the relatively small number of components needed to drive the lighting system.

[0023] FIG 4 shows RFI results of the lighting system in a plot of $\text{dB in } \mu\text{V}$ over f in MHz in a first frequency range of 9 to 30 MHz with attached testing parameters.

[0024] FIG 5 shows RFI results of the lighting system in a plot of $\text{dB in } \mu\text{V}$ over f in MHz in a second frequency range of 30 to 300 MHz.

[0025] FIGs 6 to 10 show control functions of a LED driver in a software embodiment. FIG 6 shows the respective flow diagram on a high level, including a query S1 for a dimming / no dimming routine, followed by a power control segment S2 and a frequency sweep segment S3. FIG 7 shows a more detailed view on the no-dim routine S4 that is followed by a power control routine S5 and, on FIG 8, a frequency sweep routine S6. FIG 9 shows the dim routine S7 in greater detail while FIG 10 shows a current control routine S8, followed by a sweep routine S9.

[0026] The invention is not limited to the shown exemplary embodiment. For example, the number of light sources could be otherw than three, e. g., one, two, four, or more. Also, the type of light sources is not limited LEDs but may, for example, also comprise laser diodes. Further, the microcontroller may comprise fewer functions than shown, or more, like an optical intensity control.

List of reference numbers

[0027]

1	LED driver
2	Filter stage
3	DC/DC converter
4	LEDs
5	LED current sense circuitry
6	Comparator
7	Microcontroller
8	Current control section

9	Power stage controller section
10	Input voltage sense circuit
11	Output voltage sense circuit
12	Power absorption control section
13	Thermal control section
14	Temperature sensor
15	Fan driver
16	Fan
17	Dimming control section
18	Dimming input
19	Alarms / fault conditions management section
20	LED connections
21	External connections
I _{REF}	Reference current
S1	query for dimming / no dimming routine
S2	power control segment
S3	frequency sweep segment
S4	no-dim routine
S5	power control routine
S6	frequency sweep routine
S7	dim routine
S8	current control routine
S9	sweep routine

Claims

1. A LED driver (1), comprising a microcontroller (7) that is adapted to perform at least two of the following functions:
 - LED current regulation;
 - dimming control;
 - thermal management;
 - input power absorption control;
 - input current absorption control;
 - alarms and fault conditions management; and
 - LED light optical feedback.
2. The LED driver (1) according to claim 1,
 - further comprising a connection to a LED current sensor; and
 - further comprising a current converter (3) for converting an input voltage into an LED current; and
 - the microcontroller (7) comprising a power stage controller (9),
 - such that, based on a reading of the LED current sensor, the power stage controller (9) of the microcontroller (6) is enabled to adjust the current converter (3) to set the LED current.
3. LED driver (1) according to claim 1 or 2, wherein the dimming control includes a 3-wire dimming capability.
4. The LED driver (1) according to any of the preceding

claims,

- further comprising a connection to a thermal sensor; and
- the microcontroller (7) comprising a driver circuit (15) for a fan (16),
- such that, based on a reading of the thermal sensor, the microcontroller (7) is enabled to adjust the operating condition of the fan (16).

5. The LED driver (1) according to any of the preceding claims, wherein the microcontroller (7), for input power absorption control, comprises at least one analog digital converter (10, 11) to sense an input voltage, an output current, and an output voltage, and the microcontroller (7) setting an input power assuming a statistical efficiency value.

6. The LED driver (1) according to any of the preceding claims, wherein the microcontroller (7), for a input current absorption control providing reduced RFI, is adapted to perform a sweep of the DC-DC converter switching frequency.

7. The LED driver (1) according to any of the preceding claims:

- further comprising a connection to an optical sensor; and
- the microcontroller (7) comprising a power stage controller (9)
- such that, based on a reading of the optical sensor, the microcontroller (7) is enabled to drive the power stage controller (9) in order to adjust an intensity of light emitted from at least one LED (4).

8. A method of driving a LED system, the method being performed by a microcontroller (6) and comprising at least two of the following steps:

- regulating a LED current;
- controlling a dimming function;
- performing a thermal management;
- controlling an input power absorption;
- controlling an input current absorption;
- performing an alarms and fault conditions management; and
- controlling the LED emitted light by means of optical feedback

9. The method according to claim 8, wherein the step of regulating a LED current comprises:

- reading the actual LED current;
- converting an input voltage into a LED current based on the reading of the actual LED current.

10. The method according to claim 8 or 9, wherein the step of performing a thermal management comprises:

- reading a temperature; and
- based on the reading of the temperature, adjusting the operating condition of a fan.

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11. The method according to any of the claims 8 to 10, wherein the step of controlling the dimming function comprises:

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- receiving an external dimming signal; and
- halting the power stage controller (9) for a time defined by the dimming signal.

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12. The method according to any of the claims 8 to 11, wherein the step of controlling an input power absorption comprises:

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- sensing an input voltage, an output current, and an output voltage; and
- setting an input power assuming a statistical efficiency value.

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13. The method according to any of the claims 8 to 12, wherein the step of controlling an input current absorption providing reduced RFI comprises performing a sweep of the DC-DC converter switching frequency.

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Amended claims in accordance with Rule 137(2) EPC.

1. A LED driver (1), comprising a microcontroller (7) that is adapted to perform at least the following functions:

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- LED current regulation;
- dimming control; and
- thermal management;

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wherein

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- the LED driver (1) further comprises a connection to a thermal sensor; and
- the microcontroller (7) comprises a driver circuit (15) for a fan (16),
- such that, based on a reading of the thermal sensor, the microcontroller (7) is enabled to adjust the operating condition of the fan (16).

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2. The LED driver (1) according to claim 1, comprising an analog-to-digital converter for use with the thermal management function.

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3. The LED driver (1) according to claim 1 or 2,

- further comprising a connection to a LED current sensor; and
- further comprising a current converter (3) for converting an input voltage into an LED current; and
- the microcontroller (7) comprising a power stage controller (9),
- such that, based on a reading of the LED current sensor, the power stage controller (9) of the microcontroller (6) is enabled to adjust the current converter (3) to set the LED current.

4. LED driver (1) according to any of the preceding claims, wherein the dimming control includes a 3-wire dimming capability.

5. The LED driver (1) according to any of the preceding claims, the microcontroller (7) further comprising the function of input power absorption control.

6. The LED driver (1) according to claim 5, wherein the microcontroller (7), for input power absorption control, comprises at least one analog digital converter (10, 11) to sense an input voltage, an output current, and an output voltage, and the microcontroller (7) setting an input power assuming a statistical efficiency value.

7. The LED driver (1) according to any of the preceding claims, the microcontroller (7) further comprising the function of input current absorption control.

8. The LED driver (1) according claim 7, wherein the microcontroller (7), for a input current absorption control providing reduced RFI, is adapted to perform a sweep of the DC-DC converter switching frequency.

9. The LED driver (1) according to any of the preceding claims, the microcontroller (7) further comprising the function of alarms and fault conditions management.

10. The LED driver (1) according to any of the preceding claims, the microcontroller (7) further comprising the function of LED light optical feedback.

11. The LED driver (1) according claim 10:

- further comprising a connection to an optical sensor; and
- the microcontroller (7) comprising a power stage controller (9)
- such that, based on a reading of the optical sensor, the microcontroller (7) is enabled to drive the power stage controller (9) in order to

adjust an intensity of light emitted from at least one LED (4).

12. A method of driving a LED system, the method being performed by a microcontroller (6) and comprising at least the following steps: 5

- regulating a LED current;
- controlling a dimming function; and
- performing a thermal management; 10

wherein the step of performing a thermal management comprises:

- reading a temperature; and, 15
- based on the reading of the temperature, adjusting the operating condition of a fan.

13. The method according to claim 12, wherein the step of regulating a LED current comprises: 20

- reading the actual LED current;
- converting an input voltage into a LED current based on the reading of the actual LED current. 25

14. The method according to any of the claims 12 to 13, wherein the step of controlling the dimming function comprises: 30

- receiving an external dimming signal; and
- halting the power stage controller (9) for a time defined by the dimming signal.

15. The method according to any of the claims 12 to 14, further comprising the step of: 35

- controlling an input power absorption.

16. The method according to claim 15, wherein the step of controlling an input power absorption comprises: 40

- sensing an input voltage, an output current, and an output voltage; and 45
- setting an input power assuming a statistical efficiency value.

17. The method according to any of the claims 12 to 16, further comprising the step of: 50

- controlling an input current absorption.

18. The method according to claim 17, wherein the step of controlling an input current absorption providing reduced RFI comprises performing a sweep of the DC-DC converter switching frequency. 55

19. The method according to any of the claims 12 to 18, further comprising the step of:

- performing an alarms and fault conditions management.

20. The method according to any of the claims 12 to 19, further comprising the step of:

- controlling the LED emitted light by means of optical feedback.

21. The method according to claim 20, wherein the step of controlling the LED emitted light by means of optical feedback comprises:

- reading of the optical sensor; and
- based on that reading, driving the power stage controller (9) in order to adjust an intensity of light emitted from at least one LED (4).

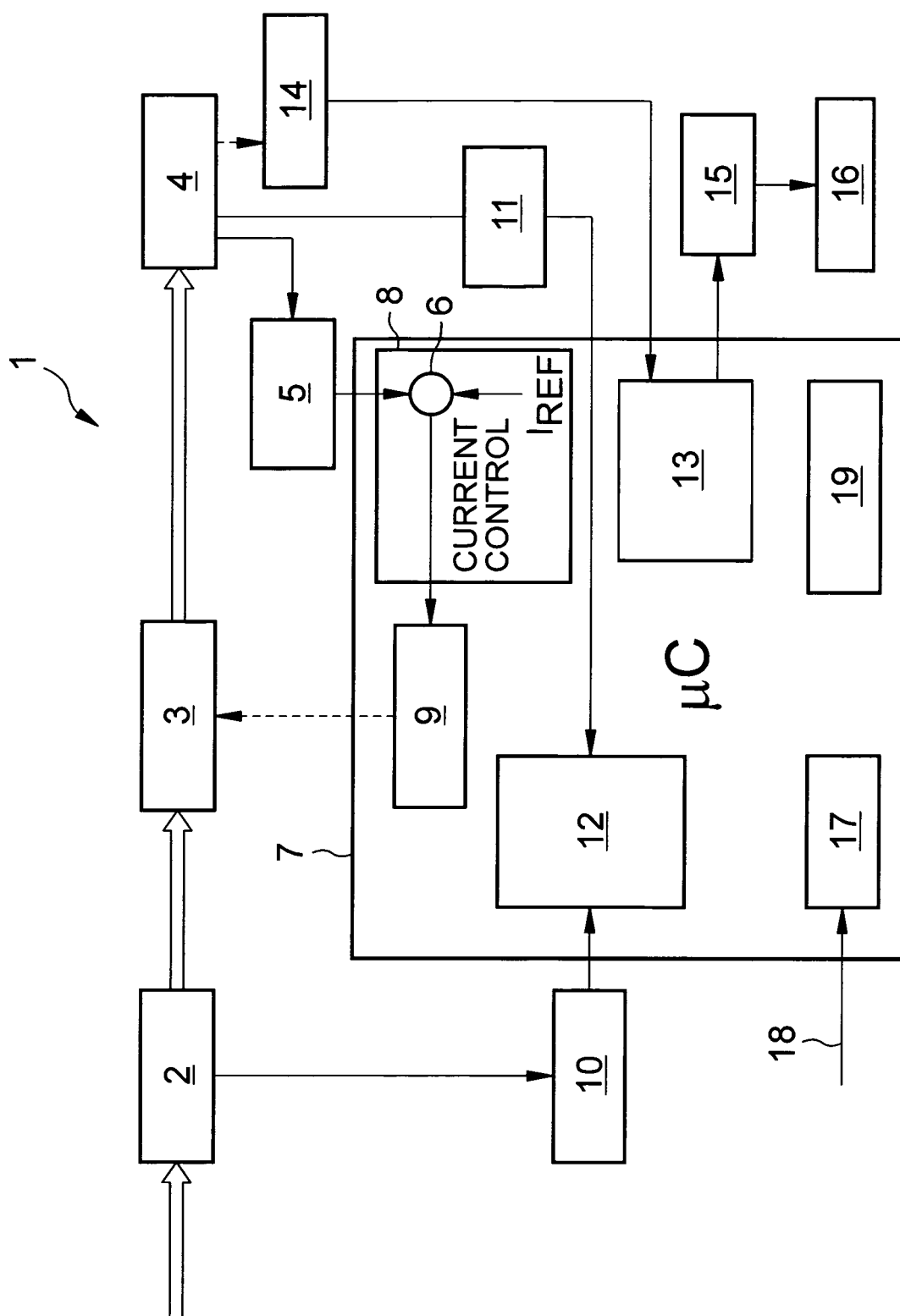


FIG 1

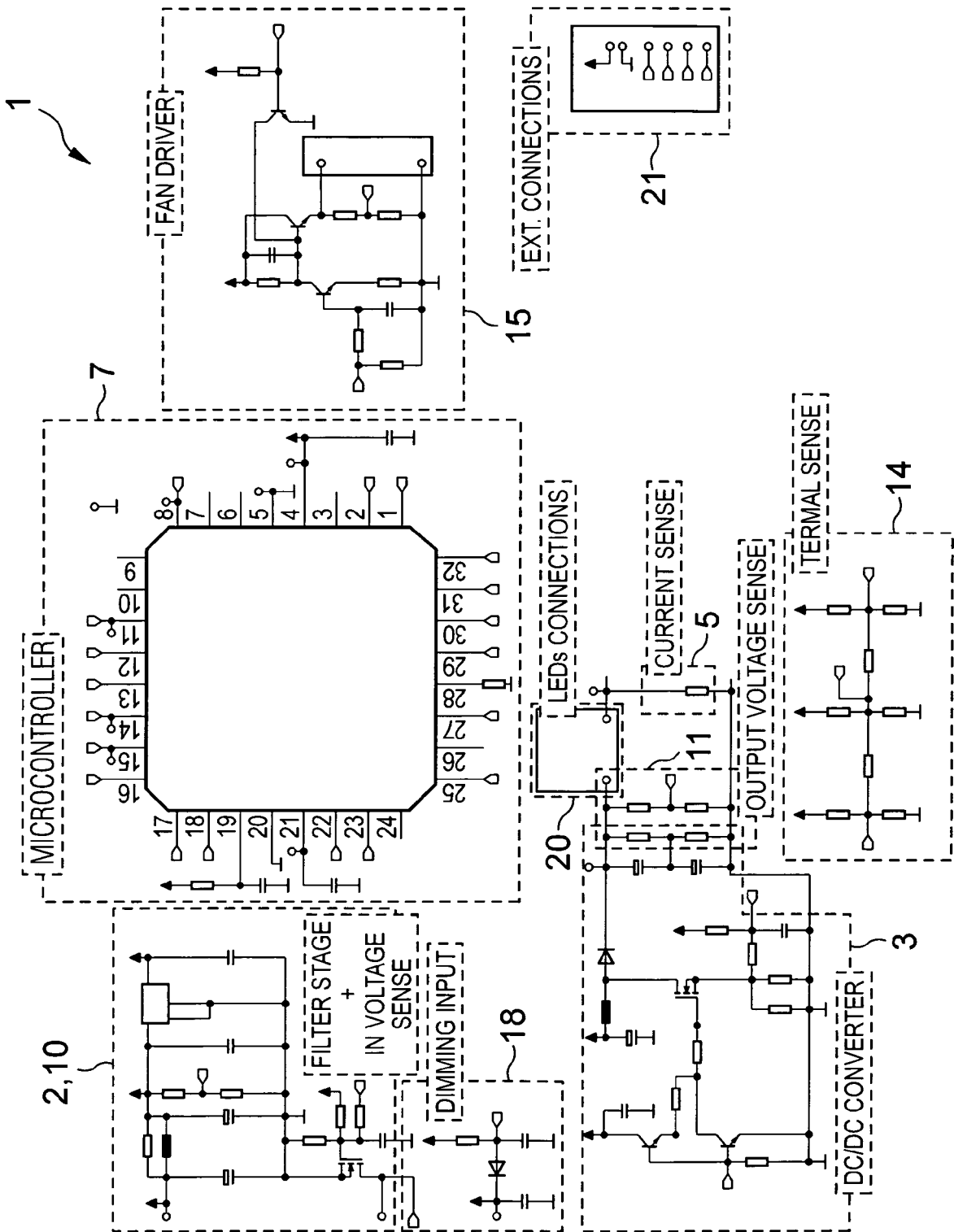


FIG 2

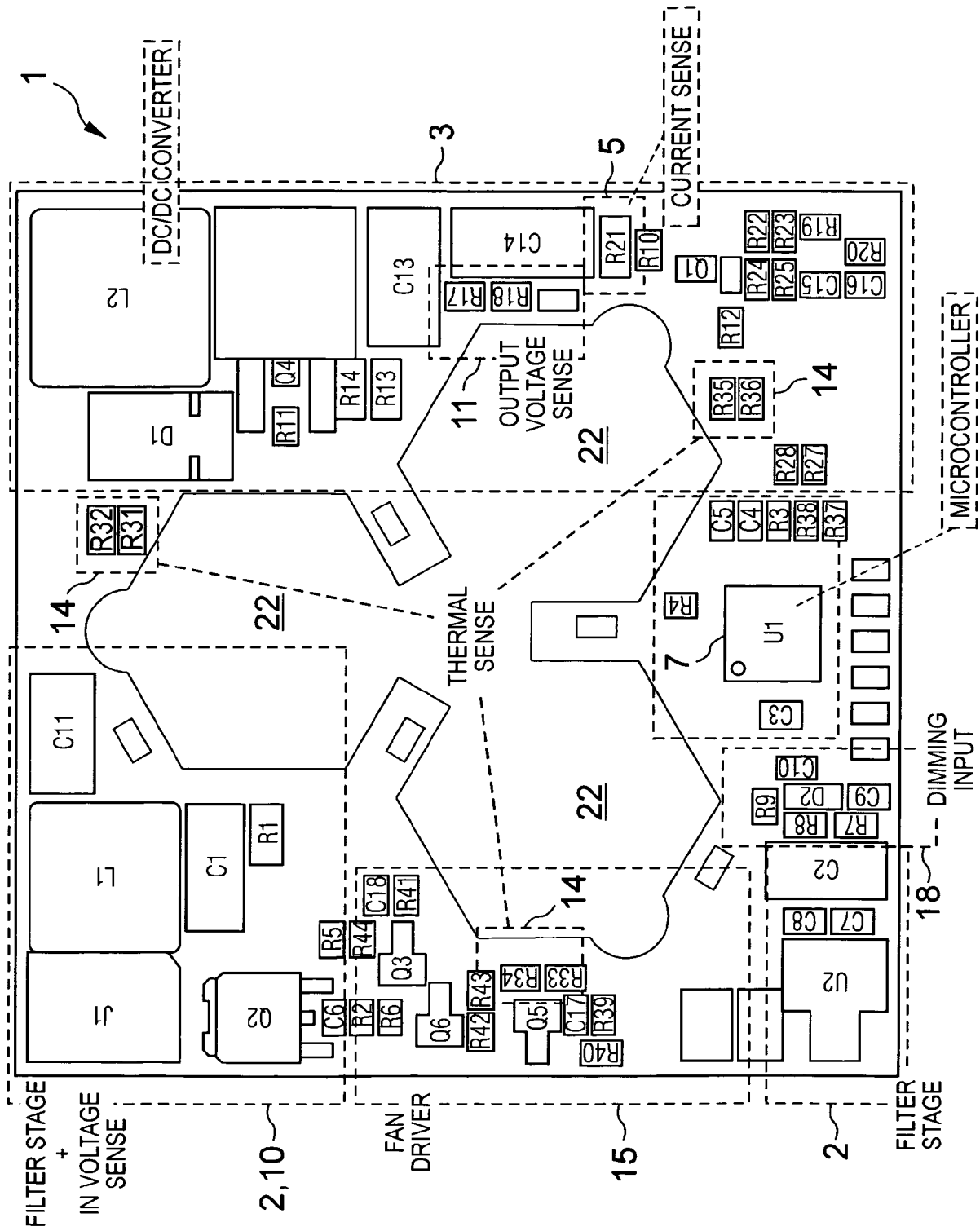
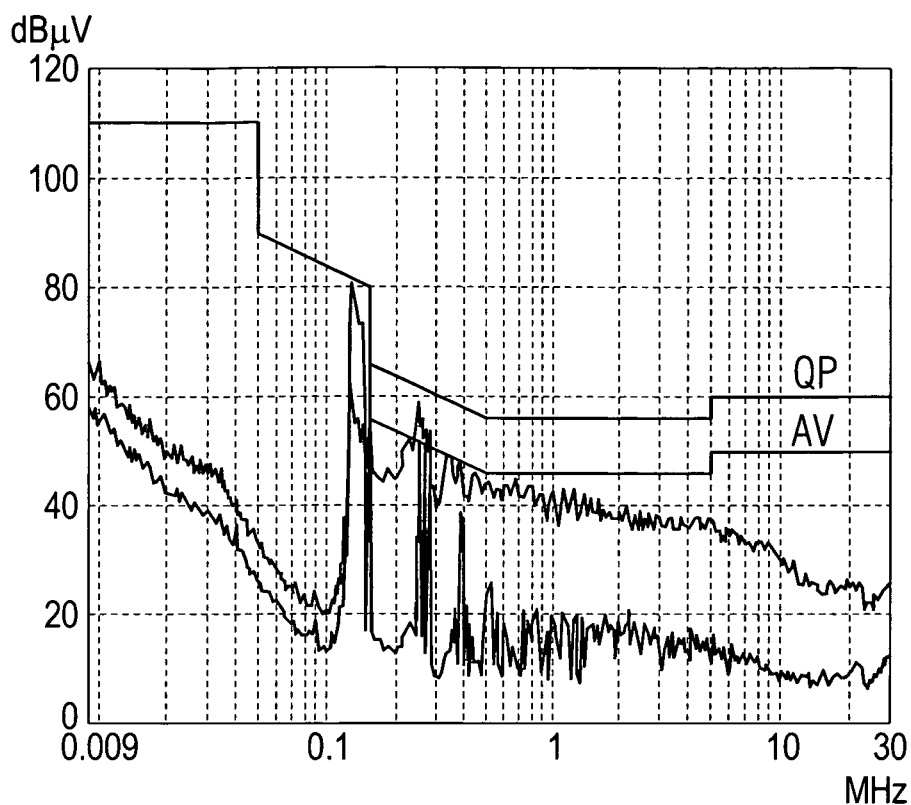


FIG 3



EUT: 03 digital 1st v.
 Manuf: OSRAM-TV
 Op Cond: 24V DC
 Operator: a.brieda
 Test Spec: cavi connessione r/n
 Comment: Primo software
 Date: 08. Mar 07 09:40

Final Measurement Results:

Indicated Phase/PE shows Configuration of max. Emission

Frequency MHz	QP Level dBμV	Delta Limit dB	Phase -	PE -
0.12750	64.4	-17.2	N	gnd
0.15000	56.2	-9.7	N	gnd
0.25000	50.9	-11.0	N	gnd
Frequency MHz	AV Level dBμV	Delta Limit dB	Phase -	PE -
0.15000	42.6	-13.4	L1	gnd
0.25000	43.3	-8.5	N	gnd

* limit exceeded

FIG 4

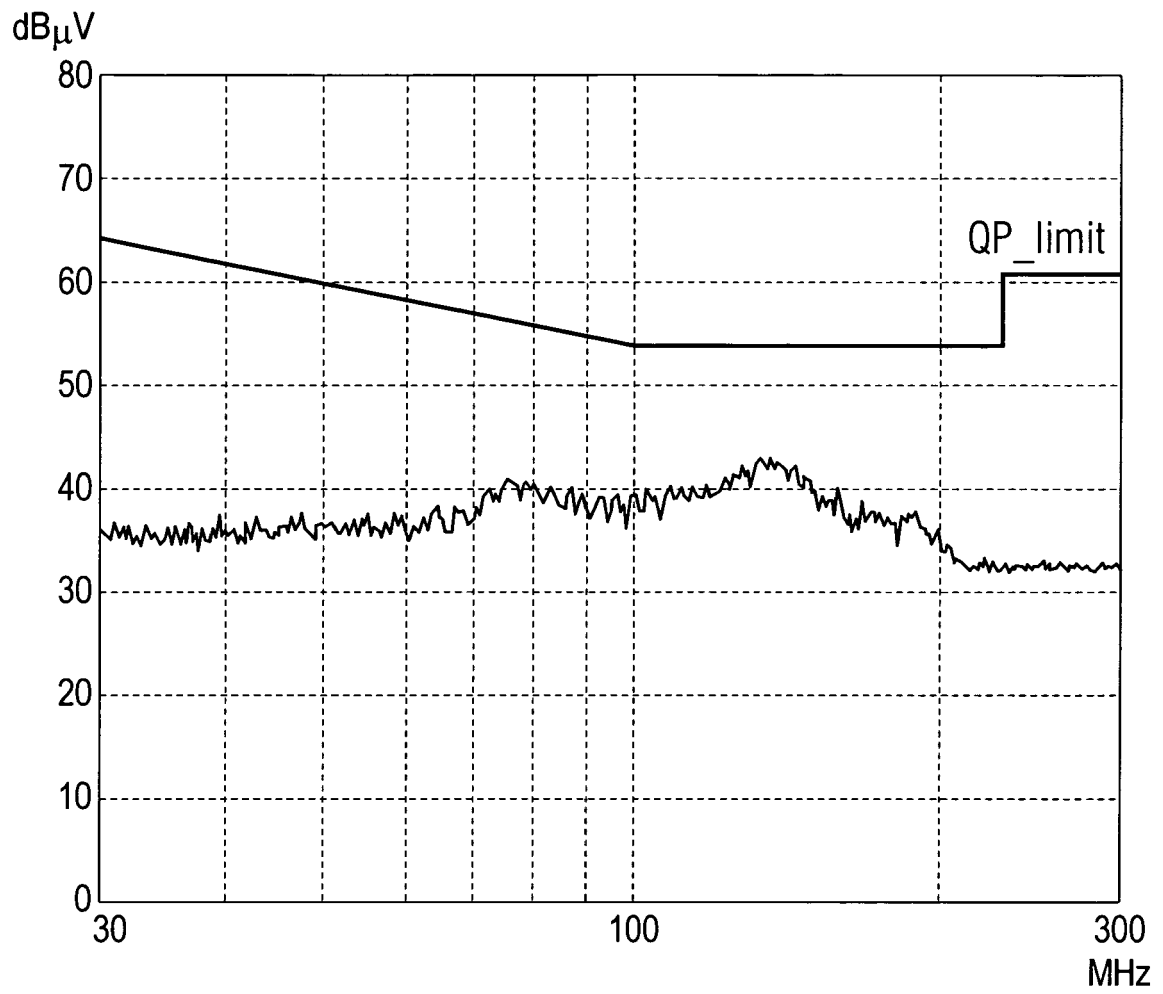


FIG 5

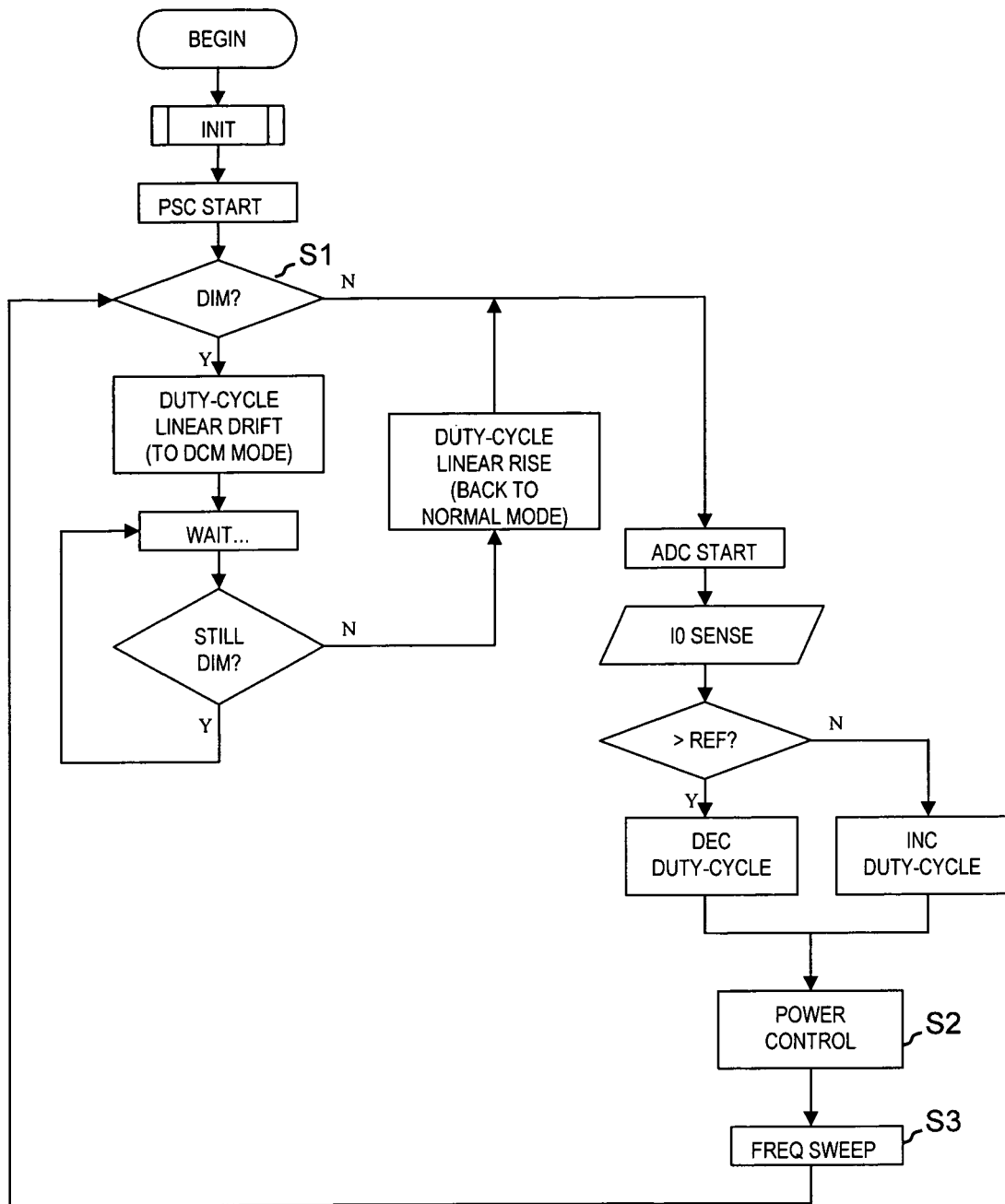


FIG 6

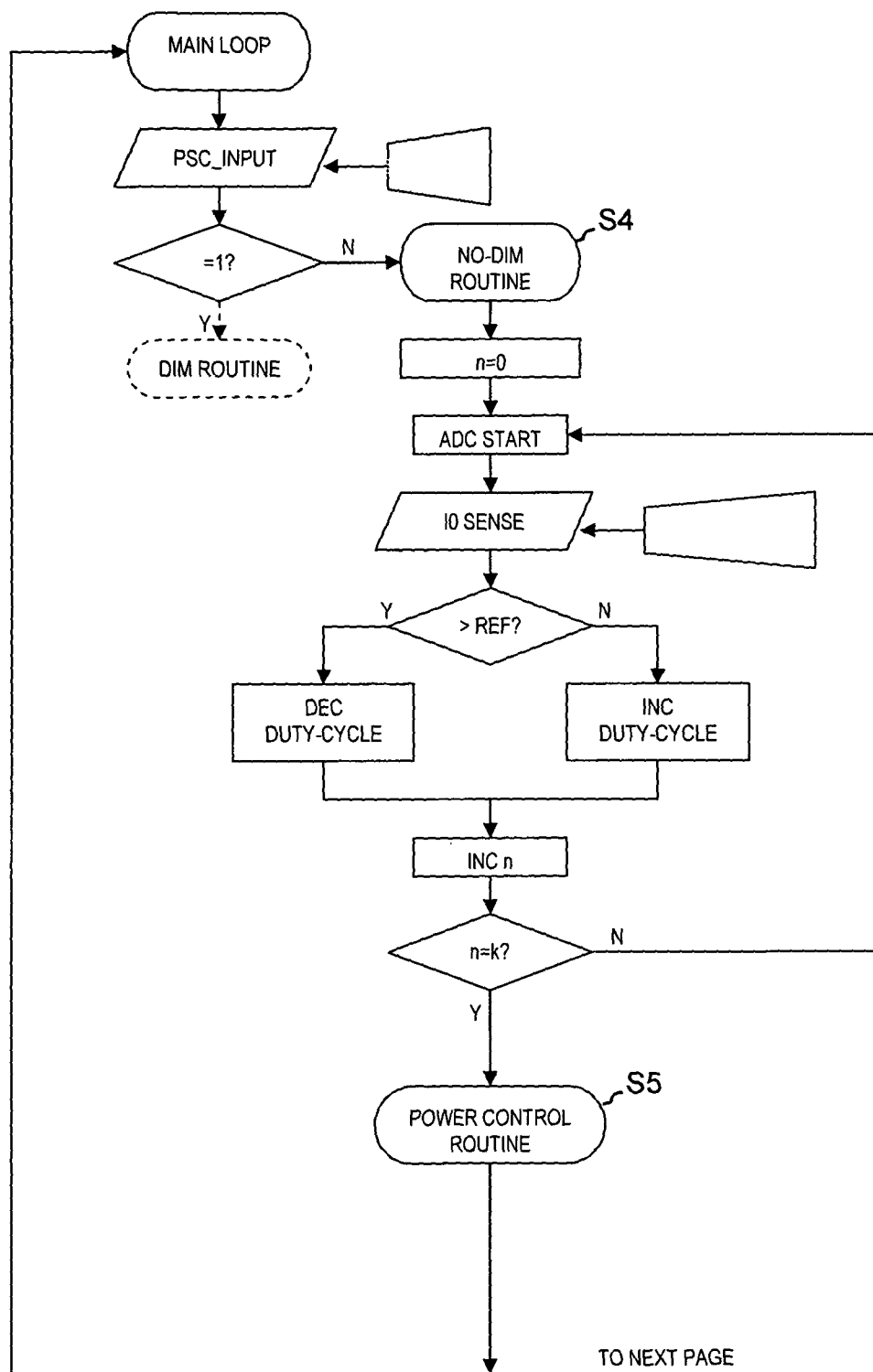


FIG 7

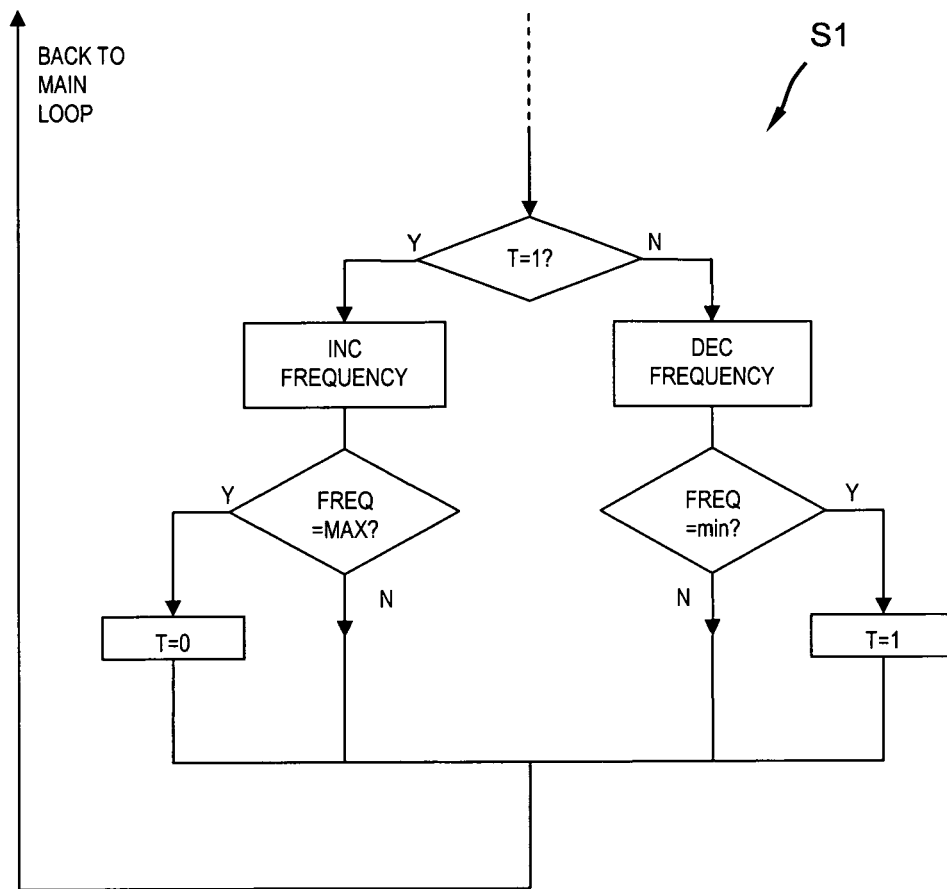


FIG 8

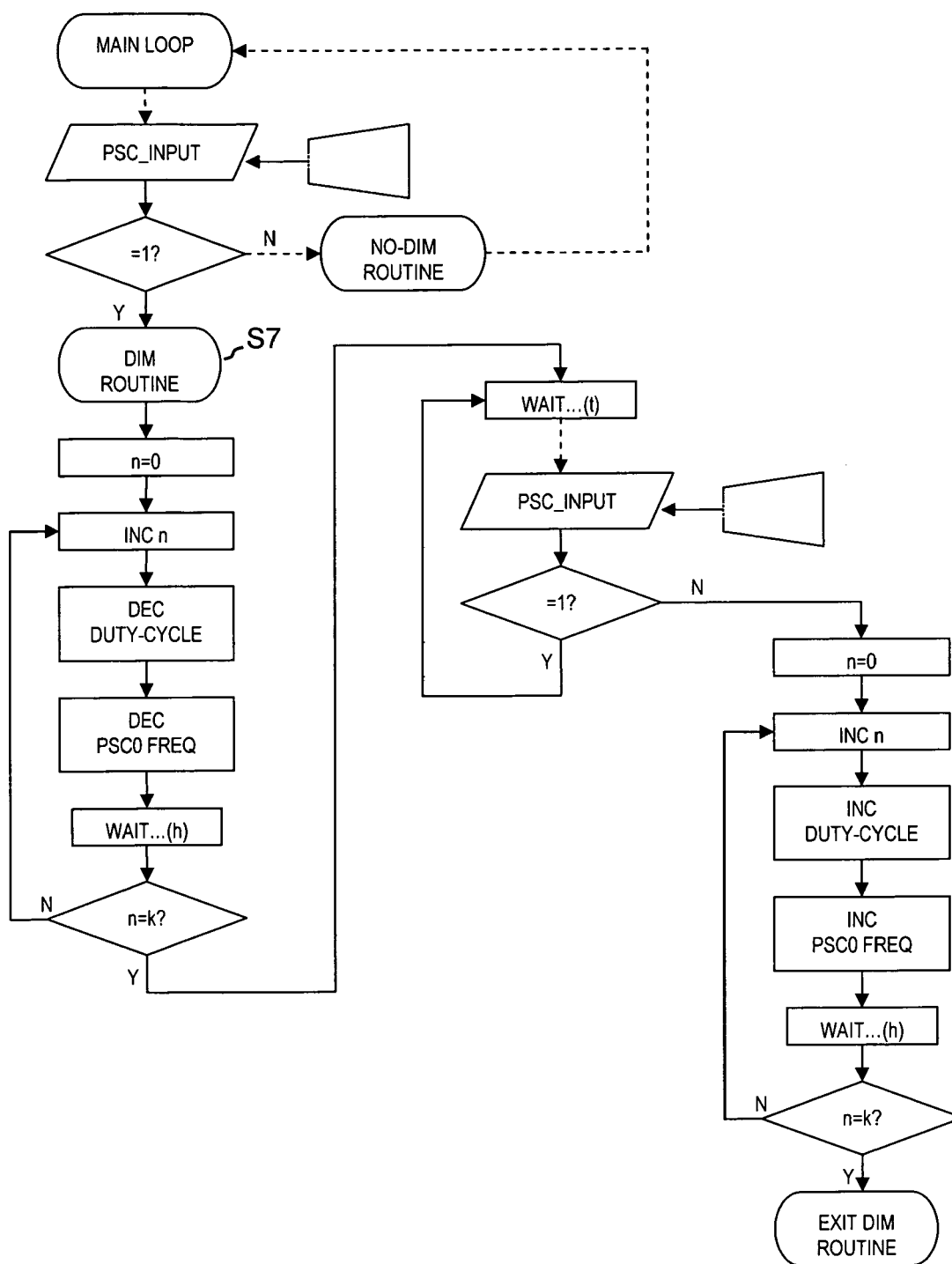


FIG 9

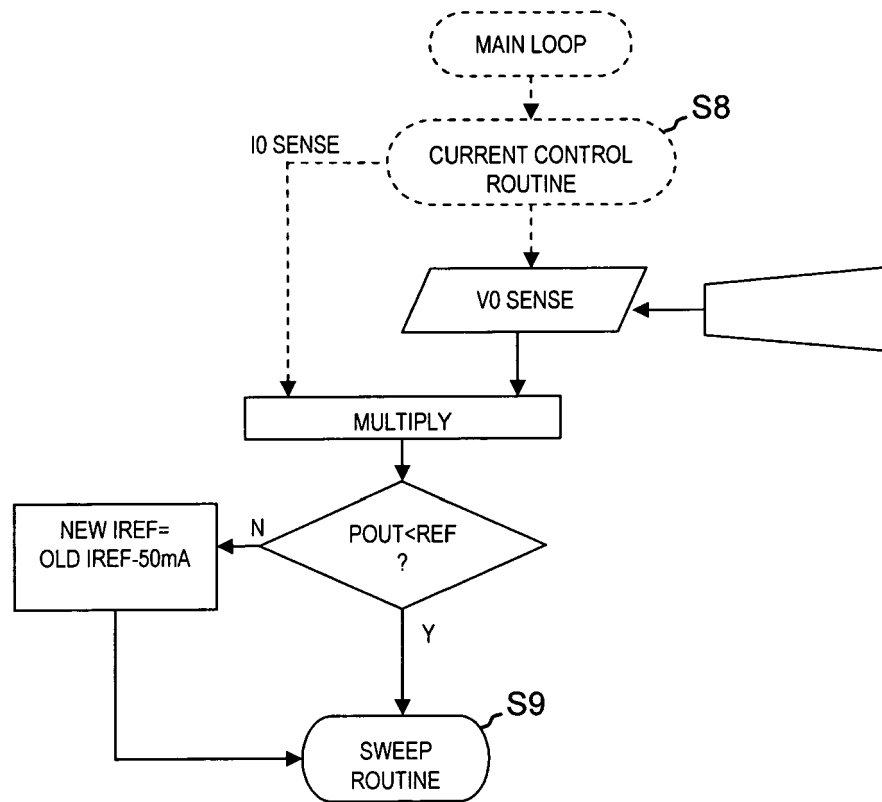


FIG 10



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Application Number
EP 07 01 0689

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<div style="display: flex; justify-content: space-between;"> <div> <p>2</p> <p>EPO FORM 1503 03.82 (P04C01)</p> </div> <div> <p>The present search report has been drawn up for all claims</p> </div> </div>			
Place of search Munich		Date of completion of the search 7 November 2007	Examiner Moll, Peter
<div style="display: flex; justify-content: space-between;"> <div> <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone</p> <p>Y : particularly relevant if combined with another document of the same category</p> <p>A : technological background</p> <p>O : non-written disclosure</p> <p>P : intermediate document</p> </div> <div> <p>T : theory or principle underlying the invention</p> <p>E : earlier patent document, but published on, or after the filing date</p> <p>D : document cited in the application</p> <p>L : document cited for other reasons</p> <p>& : member of the same patent family, corresponding document</p> </div> </div>			



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Application Number
EP 07 01 0689

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2 The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 November 2007	Examiner Moll, Peter
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EPO FORM 1503 03.82 (P04C01)



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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 November 2007	Examiner Moll, Peter
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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EPO FORM 1503 03/02 (P04C01)



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 01 0689

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
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<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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EPO FORM 1503 03/82 (P04C01)



European Patent
Office

Application Number

EP 07 01 0689

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☒ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
see annex
- ☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:



The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions LED current regulation and dimming control.

2. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions LED current regulation and thermal management.

3. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions LED current regulation and input power absorption control.

4. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions LED current regulation and input current absorption control.

5. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions LED current regulation and alarms and fault conditions management.

6. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions LED current regulation and LED light optical feedback.

7. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions dimming control and thermal management.

8. claims: 1-13



The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions dimming control and input power absorption control.

9. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions dimming control and input current absorption control.

10. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions dimming control and alarms and fault conditions management.

11. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions dimming control and LED light optical feedback.

12. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions thermal management and input power absorption control.

13. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions thermal management and input current absorption control.

14. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions thermal management and alarms and fault conditions management.

15. claims: 1-13



The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions thermal management and LED light optical feedback.

16. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions input power absorption control and input current absorption control.

17. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions input power absorption control and alarms and fault conditions management.

18. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions input power absorption control and LED light optical feedback.

19. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions input current absorption control and alarms and fault conditions management.

20. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions input current absorption control and LED light optical feedback.

21. claims: 1-13

LED driver and method of driving an LED system, comprising a microcontroller that is adapted to perform the functions alarms and fault conditions management and LED light optical feedback.



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Office

**LACK OF UNITY OF INVENTION
SHEET B**

Application Number

EP 07 01 0689

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 01 0689

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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