(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 249 620 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.11.2010 Bulletin 2010/45

(51) Int Cl.:
H05B 33/08 *(2006.01)*

(21) Application number: **09100267.5**

(22) Date of filing: **05.05.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA RS

(71) Applicant: **NXP B.V.**
5656 AG Eindhoven (NL)

(72) Inventors:
- **Schmid, M.**
  Redhill, Surrey RH1 1DL (GB)
- **Kuebrich, J. B. D.**
  Redhill, Surrey RH1 1DL (GB)
- **Duerbaum, T. A.**
  Redhill, Surrey RH1 1DL (GB)
- **Weiland, M.**
  Redhill, Surrey RH1 1DL (GB)
- **Hoogzaad, G.**
  Redhill, Surrey RH1 1DL (GB)

(74) Representative: **Hardingham, Christopher Mark**
NXP Semiconductors
Intellectual Property and Licensing Department
Betchworth House
57-65 Station Road
Redhill
Surrey RH1 1DL (GB)

(54) A ballast circuit for a lighting circuit, and a lighting circuit including a ballast circuit

(57) This invention relates to ballast circuits for lighting circuits, such as LED circuits, which can be directly driven from a mains voltage or other, off-grid, AC voltage sources. The ballast circuit comprises a SMPS without any electrolytic capacitor. The SMPS can operate to provide an unregulated voltage. By not including an electrolytic capacitor, the cost, bulk, and life-time limitations associated with such a capacitor are avoided.

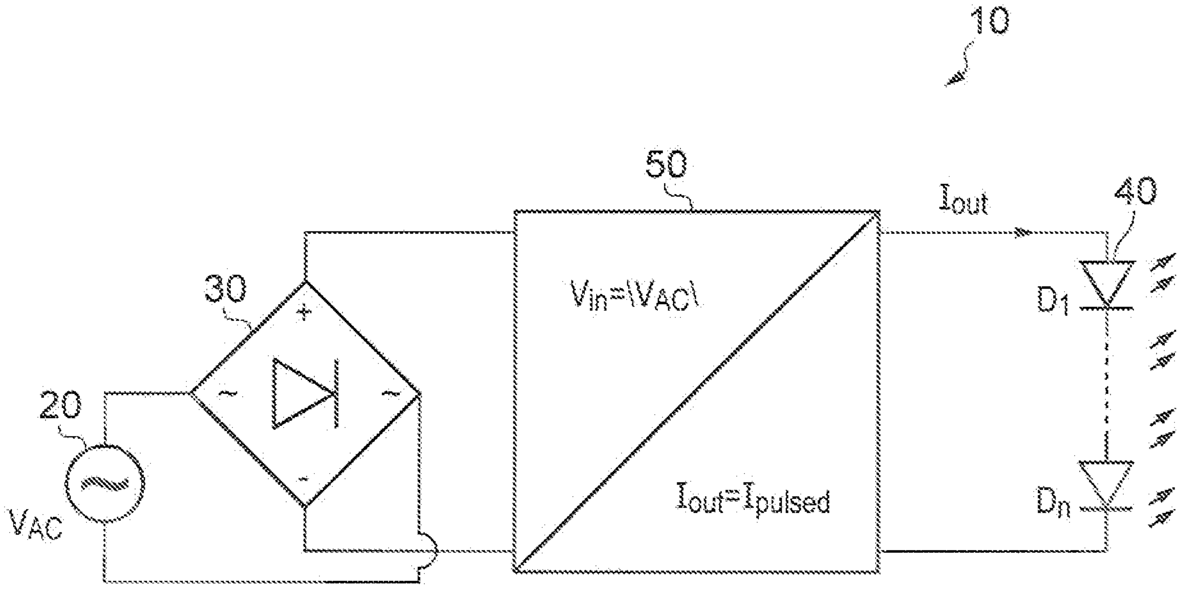


FIG. 1

EP 2 249 620 A1

Description

Field of the Invention

[0001] This invention relates to ballast circuits for lighting circuits, which lighting circuits are adapted to be directly driven from mains or similar power sources. It further relates to lighting circuits including such ballast circuits.

Background of the Invention

[0002] Currently, incandescent light-bulbs and fluorescent lamps dominate the market for lighting devices for general illumination. However, since the advent of the white light emitting diode (LED), LED lighting is starting to become a realistic possibility for general illumination purposes such as domestic and commercial lighting. LED lighting will become increasingly more important to an energy-conscious society, since in comparison with traditional incandescent light-bulbs which typically achieve a luminous efficiency of around 10 to 20 lm/W, LEDs already achieve efficiencies of approximately 50 to 100 lm/W. Furthermore, LEDs offer the prospect of long lifetimes, when compared with conventional lighting devices.

[0003] Conventional LEDs operate at a voltage of between 1.5 and 5 V, depending on their colour, type, temperature and operational conditions. Furthermore, LEDs have a very small dynamic resistance; thus directly connecting an LED to a voltage source can result in large current values. It is therefore generally not practicable to drive LEDs directly from a mains supply: protective circuitry is necessary, to prevent damage to the LEDs in the case of fluctuations of the voltage in the mains supply. The simplest way of providing a protective circuit is by means of a resistor connected in series with the LEDs. However, this method is associated with high losses and is thus not desirable. As a consequence a ballast may be used in front of the LEDs. An example of such a ballast is a switched mode power supply (SMPS).

[0004] SMPSs operate by supplying a rapidly chopped or pulsed output current. The chopping is typically in frequency range between several kHz and several MHz. In order to provide acceptably smooth output characteristics, either current or voltage, SMPSs include a large electrolytic capacitor on either the input or the output side to smooth the pulsed current. Such an electrolytic capacitor adds to the cost and the volume of SMPSs, and renders them non-ideal for use as a ballast for mains-driven LED circuits. Furthermore, an electrolytic capacitor may be limiting to the lifetime of the ballast.

[0005] There is therefore an ongoing need for an LED ballast circuit, which suffers to a lesser extent or not at all from the above disadvantages.

Summary of the invention

[0006] It is an object of the present invention to provide a ballast circuit for a lighting circuit which is at least one of inexpensive and small and having a high lifetime.

[0007] According to the present invention there is provided a ballast circuit for a mains-driven lighting circuit, the ballast circuit comprising a switched mode power supply, **characterised in that** the switched mode power supply is adapted for operation as a current generator, and the switched mode power supply does not comprise an electrolytic capacitor. Reduced costs, and an extension of the lifetime of the lighting circuit, may thereby be achieved. In particular, by not using an electrolytic capacitor, the limitation of lifetime of the circuit which could otherwise result from heat-induced failure of the electrolytic capacitor due to proximity of with the LEDs, can thereby be avoided. Preferably, not only is there no capacitor with mains-frequency storage capability but also no inductor with mains-frequency storage capability. Thus preferably, the circuit has an inductance of less than 10mH and more preferably less than 0.1mH.

[0008] In embodiments the switched mode power supply comprises a flyback converter comprising a primary inductor coupled to a secondary inductor and a freewheeling diode. A flyback converter is a particularly inexpensive and convenient type of SMPS.

[0009] In embodiments the flyback converter further comprises an input capacitor having capacitance less than 1 μF, or preferably less than 0.22 μF. Such a small input capacitor can provide a useful smoothing function, and facilitate compliance with putative or existing regulations regarding on mains supplies. It is noteworthy that such a capacitor has only a smoothing function for the high frequency oscillations of the SMPS, and is thus useful for EMC reasons: it has no mains frequency capability.

[0010] In embodiments, the limiting (maximum) allowable value of the capacitance is dependant on the power of the device: for example the appropriate value of an EMI-filter (Electro Magnetic Interference) capacitor depends on the power to be transferred. This capacitor could be larger than 220nF with increasing power but even if it was larger it is still only used for EMI-filtering purposes. Higher power levels need larger capacitances for EMI-filtering.

[0011] Preferably the ballast circuit further comprises a controller adapted to control a primary current through the primary inductor, in dependence on an input voltage. Such a control method is particularly convenient and simple and avoids the need for complex and expensive feedback mechanisms.

[0012] In embodiments, the ballast circuit further comprises an output capacitor with a capacitance which is less than 10μF or more preferably less than 1μF. Such a small output capacitor may be useful in order to improve the operation and/or the efficiency of the lighting circuit. Once again it is noteworthy that such a capacitor has no mains-frequency storage capability, and thus would not be an electrolytic capacitor.

[0013] In embodiments, the switched mode power supply is a resonant converter. Alternatively, the switched mode power supply is one of a Sepic-, Zeta- or Cuk- converter. In yet more alternative embodiments, the switched mode power supply is one of a buck-derived forward-converter, half-bridge converter or full-bridge converter.

[0014] According to another aspect of the present invention, there is provided a power factor correction circuit for a lighting circuit which is adapted to be directly mains-driven, the power factor correction circuit comprising a ballast circuit as described above and which does not comprise an electrolytic capacitor

[0015] According to yet another aspect of the present invention, there is provided a lighting circuit adapted to be directly mains-driven, which comprises a ballast circuit as described above and which does not comprise an electrolytic capacitor. Without limitation, the lighting circuit may comprise an LED circuit or an OLED circuit.

[0016] An SMPS driven in accordance with embodiments of the invention may be arranged to provide a nearly unity power factor. Thus, the SMPS works as a power factor correction circuit such that the lighting circuit will draw a current from the mains (or other) line input which can comply with present or future national or international regulations regarding power factors for mains-connected loads. Currently there are no regulations regarding a harmonics for lighting devices having low power consumption, but it can be envisaged that as such devices become more prevalent, restrictions on the harmonics of the drawn line currents may be imposed.

[0017] These and other aspects of the invention will be apparent from, and elucidated with reference to, the embodiments described hereinafter.

Brief description of Drawings

[0018] Embodiments of the invention will be described, by way of example only, with reference to the drawings, in which

Fig. 1 shows a ballast circuit in a lighting circuit, according to an embodiment of the invention;

Fig. 2 shows schematically current supplied by a circuit such as that of Fig. 1;

Fig. 3 shows a schematic of a lighting circuit incorporating a fly-back converter;

Fig. 4 shows the input current and the input voltage, for a demonstrator lighting circuit;

Fig. 5 shows a schematic similar to figure 1 but including a high-frequency output filter; and

Fig. 6 shows a schematic of a lighting circuit incorporating a forward converter.

[0019] It should be noted that the Figures are diagrammatic and not drawn to scale. Relative dimensions and proportions of parts of these Figures have been shown exaggerated or reduced in size, for the sake of clarity and convenience in the drawings. The same reference signs are generally used to refer to corresponding or similar feature in modified and different embodiments.

Detailed description of embodiments

[0020] Figure 1 shows a ballast circuit in a lighting circuit according to a first embodiment of the present invention. The lighting circuit 10 is driven from a mains power source 20 which supplies an AC voltage V_{AC}, which is rectified by rectifier 30 to rectified voltage $|V_{AC}|$ and used to drive a series string of LEDs 40. Between the rectifier 30 and the string of LEDs 40 is included a ballast circuit 50. The ballast circuit 50 takes as input V_{in} the rectified AC voltage $|V_{AC}|$, and supplies an output current I_{out}, which takes the form of a pulsed AC current I_{pulsed}. The ballast circuit 50 operates as a switched mode power supply without any output smoothing.

[0021] The ballast circuit 50 provides a pulsating output current to drive the LEDs 40. By not using an output capacitor, the light emitting diodes are supplied with a rectified current, whose average value pulsates with a frequency corresponding to twice that of the mains input frequency. Thus, for example, for a mains frequency of 50 Hz, the LEDs are supplied with a current whose average value pulsates at 100 Hz. Superposed on the twice-mains frequency pulsations, is the triangular waveform of the instantaneous current, which varies with a frequency in this case of 2kHz (for clarity), and typically between 20kHz and several MHz.

[0022] Figure 2 shows schematically the current which is supplied to the string of LEDs 40. Over the time interval of 0.01 seconds shown in the figure, the average LED current 210 goes through a single pulse corresponding to a pulsation frequency of 100 Hz and a mains input frequency of 50 Hz. Also shown in the figure is the LED instantaneous current 220. The peaks of the instantaneous current 220 follow the shape of the pulse in the average current. However, as the LED current 220 corresponds to the output of the SMPS and is absent any smoothing at all, the chopping frequency of the SMPS (in this case 2 kHz) is evident in the generally triangular high frequency waveform, or ripple. As mentioned above, in practice, a chopping frequency of the SMPS is normally set to a higher value than the 2 kHz value shown in figure 2 which was chosen primarily for illustrative purposes. It will be appreciated that, in other embodiments wherein a small value (less than 10μF and typically less than 1μF) non-electrolytic output capacitor is included, the capacitor has the effect of smoothing the high frequency chopping or ripple 220, but has no impact on the twice-mains frequency average current pulsation 210.

[0023] Figure 3 shows a schematic circuit of a lighting circuit incorporating a fly-back converter. A fly-back converter has been chosen as a non-limiting example of a type of SMPS to which the invention applies. The lighting circuit 300 is supplied with alternating input voltage V_{AC}

310, which is rectified by rectifier 320 to provide an input $|V_{AC}|$ to the flyback converter 350. Flyback converter 350 supplies output current I_{out} to a string of diodes 340 comprising diodes D_1 to D_n. The flyback converter 350 comprises coupled chokes or inductors Lp and L_s, a switch S and a freewheeling diode D on the output side. The freewheeling diode D is included despite the existing string of LEDs 340, in order to absorb the reverse voltage in case of a conducting switch S. As is apparent from figure 3, a bulky electrolytic capacitor is utilised on neither the input side nor the output side of flyback converter 350. However, a smaller filter capacitor C_F is placed across the input of the SMPS, and filter inductors L_{F1} and L_{F2} are included on both the live and neutral rails of the mains input 310. These components are included in order to filter out any high frequency parts of the line current. It is emphasised that they do not provide any smoothing function in the fundamental frequency range of the mains input. The filter capacitor C_F is small enough so that effectively it is always charged to the actual value of the rectified input voltage.

[0024] In operation, while the switch S is conducting, an approximately linearly increasing current flows through the primary inductance Lp. On the secondary side no current flows. When the switch S is toggled to an off-stage, energy $1/2 \cdot L_p \cdot i_{Pmax}^2$ is stored in the inductor, where i_{Pmax} is the maximum current in the primary inductor just prior to switch-off of the switch S. This energy will be delivered to the secondary circuit. Consequently an approximately linearly decreasing current flows through the LEDs 340. As a result, the current provided to the LEDs is, as shown in Fig. 2, nearly triangular.

[0025] The timing of the switching of switch S is under control of controller 352. A conventional controller IC may be used; however, since a feedback controller loop is not desirable, an alternative controller mechanism may be employed, which avoids the complexity of a feedback loop such as is often employed and involving expensive opto-couplers: instead of measuring the output voltage, the corresponding pin on the controller is used to control the maximum primary current in dependence on the value of the input voltage. The switch S is switched off when the given, or pre-determined, maximum primary current is reached. Thus this embodiment as shown provides a open-loop feed-forward control; however, it will readily be appreciated that the invention is not limited thereto, and is equally applicably to other closed loop control, such as feed-back control, and that, furthermore, standard power-factor correction control schemes like CCM/DCM-operation (Continuous Conduction Mode/ Discontinuous Conduction Mode) or BCM-operation (Boundary Conduction Mode) can be implemented without departing from the invention.

[0026] Figure 4 shows the input current 420 and the input voltage 430, for a demonstrator lighting circuit including a fly-back converter SMPS as described above with reference to figure 3. The converter is driven in boundary conduction mode. As shown, the input current 420 broadly follows the cycling of the input mains voltage 430, and thus can be anticipated to satisfy any future EMC regulations which may limit the harmonics of mains currents.

[0027] A further embodiment of the invention is shown in figure 5. Figure 5 shows a lighting circuit 510 which is broadly similar to that of figure 1: corresponding components are referenced by corresponding numerals, and will not be further described. However, this embodiment includes a filter 560 on the output side of the SMPS. The easiest filter implementation is the usage of a small capacitor (ceramic or film capacitor) but also a higher order filter such as a C-L-C-filter is usable. The value of the output capacitor is typically less than 10 μF, and in a preferred embodiments it is less than 1μF. Note that this output filter does not correspond to the conventional electrolytic capacitor placed on the output of an SMPS, so no mains-frequency or 50Hz filter is employed; instead of a large electrolytic output capacitor, a small capacitor is placed in parallel to the LEDs. Thus the low frequency 100Hz-ripple will still exist - since there is no large electrolytic capacitor to provide the smoothing function for this ripple - but the high frequency ripple caused by the switching actions can be reduced or even eliminated. Although this embodiment involves higher costs than that described above, since the capacitor is relatively small, the increase in costs and volume is minor and inclusion of such a high frequency smoothing can result in a considerably higher luminous efficiency, as the LEDs can thereby be arranged to operate close to their optimum operating point for a larger part of the time.

[0028] The above embodiments have been described using a flyback topology to convert a rectified input voltage to a pulsating current delivered to the LEDs. However, it will be immediately apparent to the skilled person that the invention is not limited to flyback topology, but other topologies such as Sepic-, Zeta- or Cuk-converter, the buck-derived Forward-converter, Half- and Full-bridges as well as resonant converters are all is suitable for use with the present invention. Thus the invention is not limited to flyback converter but is applicable to SMPS in general including buck and forward converters.

[0029] Figure 6 shows a schematic of a lighting circuit 600 incorporating a forward converter, including a small output filter 660, according to an embodiment of the invention. Forward converter 650 is provided with mains input 610 which has been fully rectified by rectifier 620, to provide rectified input $|V_{AC}|$. Forward converter 650 may comprise a small input filter C_{F1}, and has a control switch S in series with primary coil Lp of transformer 654 and operable under control of controller 652. The output from the secondary coil Ls of the transformer 654 is rectified by diode D_1; a freewheeling diode D_2 is also included. The forward converter 650 further comprises an inductor L on the secondary side circuit. The skilled person will immediately appreciate that this inductor is integral to the operation of the forward converter, and does not form a smoothing function equivalent to an output filter.

[0030] For the sake of completeness, it is mentioned that Figure 6 does not show any necessary reset winding or mechanism: the skilled person will appreciate that the invention is not thereby constrained, and may be used with any suitable reset mechanism.

[0031] The embodiment shown in figure 6 includes an optional small capacitor C_{F2} which functions as a *high frequency* output filter. Thus, it is emphasised, capacitor C_{F2} is not a large electrolytic, and has no capability for storage or smoothing the 100Hz or twice-mains-frequency pulsation. However, it can smooth the high-frequency chopping or ripple caused by the forward converter itself.

[0032] The invention has been described above primarily with reference to LED lighting applications. However, it will be immediately apparent to the skilled person that that's the invention is applicable to other forms of lighting. In particular the invention embraces organic LED lighting (OLED), electroluminescent lighting (EL), and cathodo-luminescent lighting (CL).

[0033] Furthermore, embodiments of the invention described above are associated with a mains input supply such as that supplied through a grid. It will be immediately apparent to the skilled person that the invention is not limited to mains input voltages but is equally applicable to other AC voltages which may be for instance generated off-grid. An example of such an off-grid generated AC input voltage is that produced by a local generator, such as a petrol-driven generator, for example on board a ship or in a remote environment.

[0034] In summary, there has been disclosed an invention which relates to ballast circuits for lighting circuits, such as LED circuits, which can be directly driven from a mains voltage or other, off-grid, AC voltage sources. The ballast circuit comprises a SMPS without any electrolytic capacitor. The SMPS can operate to provide an unregulated voltage. By not including an electrolytic capacitor, the cost, bulk, and life-time limitations associated with such a capacitor are avoided.

[0035] From reading the present disclosure, other variations and modifications will be apparent to the skilled person. Such variations and modifications may involve equivalent and other features which are already known in the art of lighting, and which may be used instead of, or in addition to, features already described herein.

[0036] Although the appended claims are directed to particular combinations of features, it should be understood that the scope of the disclosure of the present invention also includes any novel feature or any novel combination of features disclosed herein either explicitly or implicitly or any generalisation thereof, whether or not it relates to the same invention as presently claimed in any claim and whether or not it mitigates any or all of the same technical problems as does the present invention.

[0037] Features which are described in the context of separate embodiments may also be provided in combination in a single embodiment. Conversely, various features which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination.

[0038] The applicant hereby gives notice that new claims may be formulated to such features and/or combinations of such features during the prosecution of the present application or of any further application derived therefrom.

[0039] For the sake of completeness it is also stated that the term "comprising" does not exclude other elements or steps, the term "a" or "an" does not exclude a plurality, a single processor or other unit may fulfil the functions of several means recited in the claims and reference signs in the claims shall not be construed as limiting the scope of the claims.

Claims

1. A ballast circuit for a mains-driven lighting circuit, the ballast circuit comprising
a switched mode power supply,
characterised in that
the switched mode power supply is adapted for operation as a current generator, and
the switched mode power supply does not comprise an electrolytic capacitor.

2. A ballast circuit as claimed in claim 1, wherein the switched mode power supply comprises a flyback converter comprising a primary inductor (Lp) coupled to a secondary inductor (Ls) and a freewheeling diode (D).

3. A ballast circuit as claimed in claim 2, wherein the flyback converter further comprises an input capacitor having capacitance less than 220nF.

4. A ballast circuit as claimed in any preceding claim, further comprising a controller adapted to control a primary current through the primary inductor, in dependence on an input voltage.

5. A ballast circuit as claimed in any preceding claim further comprising an output capacitor with a capacitance which is less than 1μF.

6. A ballast circuit as claimed in claim 1, wherein the switched mode power supply is a resonant converter

7. A ballast circuit as claimed in claim 1, wherein the switched mode power supply is one of a Sepic-, Zeta- or Cuk- converter.

8. A ballast circuit as claimed in claim 1, wherein the switched mode power supply is one of a buck-derived forward-converter, half-bridge converter or full-bridge converter.

9. A power factor correction circuit for a lighting circuit which is adapted to be directly mains-driven, the power factor correction circuit comprising a ballast circuit as claimed in any preceding claim and does not comprise an electrolytic capacitor

10. A lighting circuit adapted to be directly mains-driven, and which comprises a ballast circuit as claimed in any preceding claim, and does not comprise an electrolytic capacitor.

11. A lighting circuit as claimed in claim 10 comprising an LED circuit

12. A lighting circuit as claimed in claim 10 comprising an OLED circuit

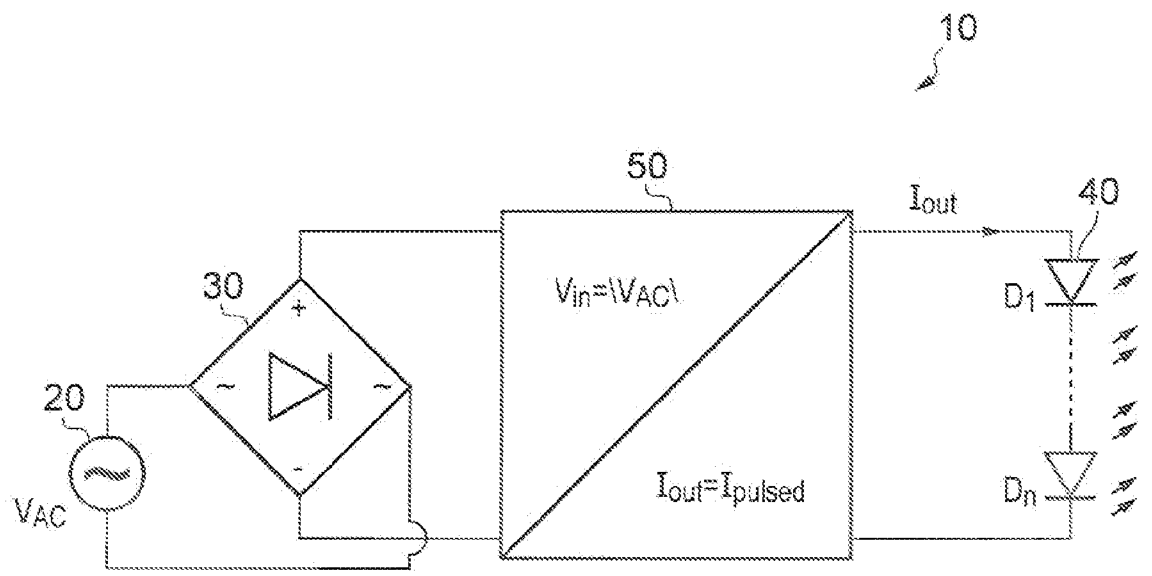

10
50
Iout
40
30
20
VAC
Vin=|VAC|
Iout=Ipulsed
D1
Dn
+
~
~
-

FIG. 1

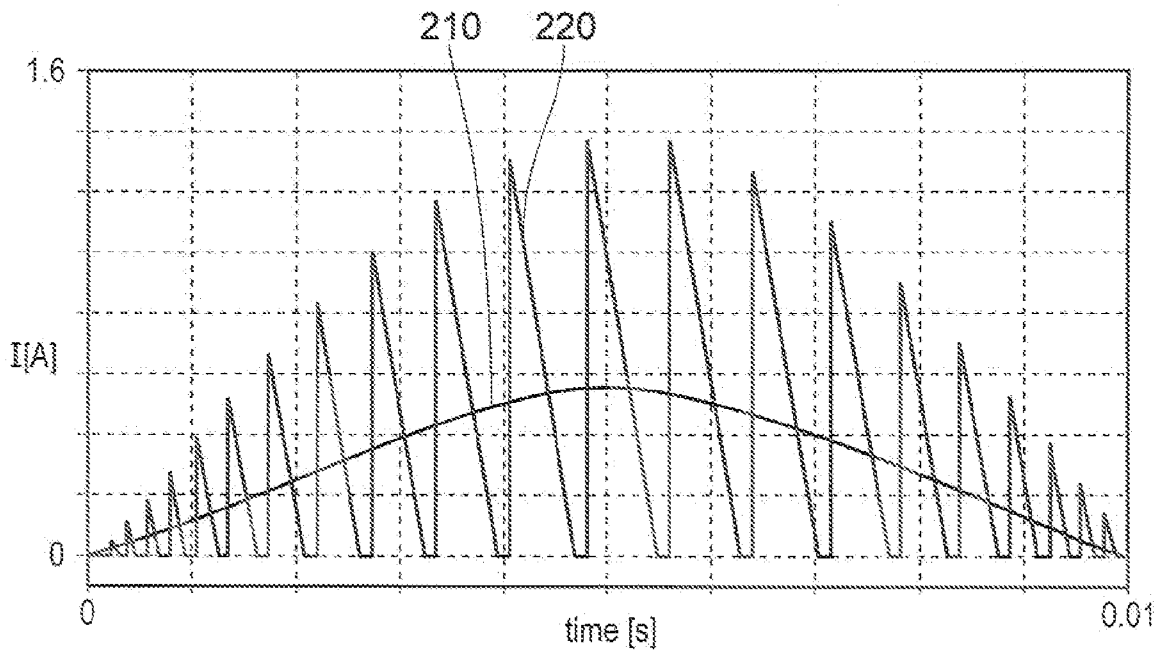

210
220
1.6
I[A]
0
0
time [s]
0.01

FIG. 2

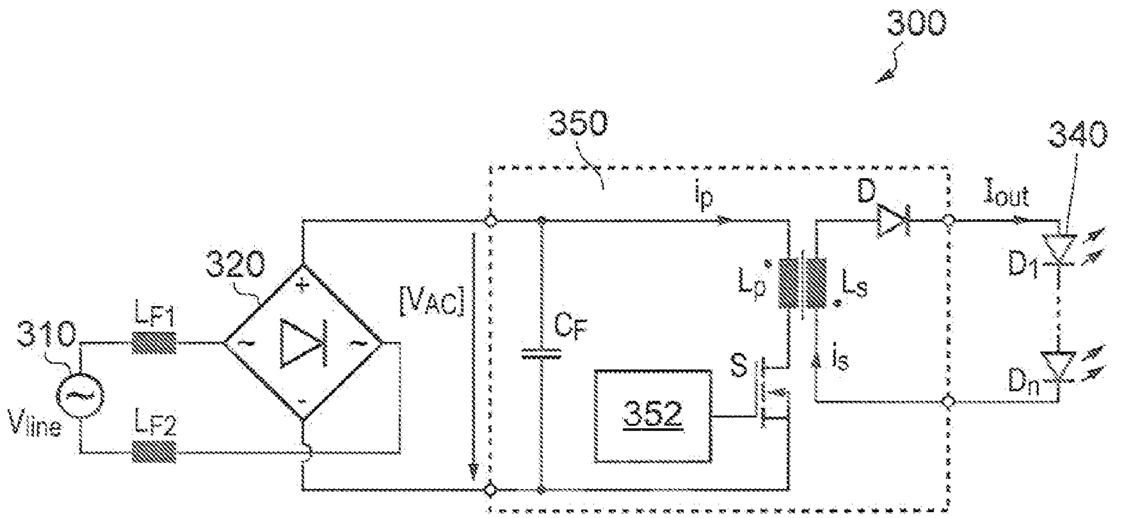

300
350
340
320
310
V_{line}
L_{F1}
L_{F2}
[V_{AC}]
C_F
i_p
D
I_{out}
L_p
L_s
S
i_s
352
D_1
D_n

FIG. 3

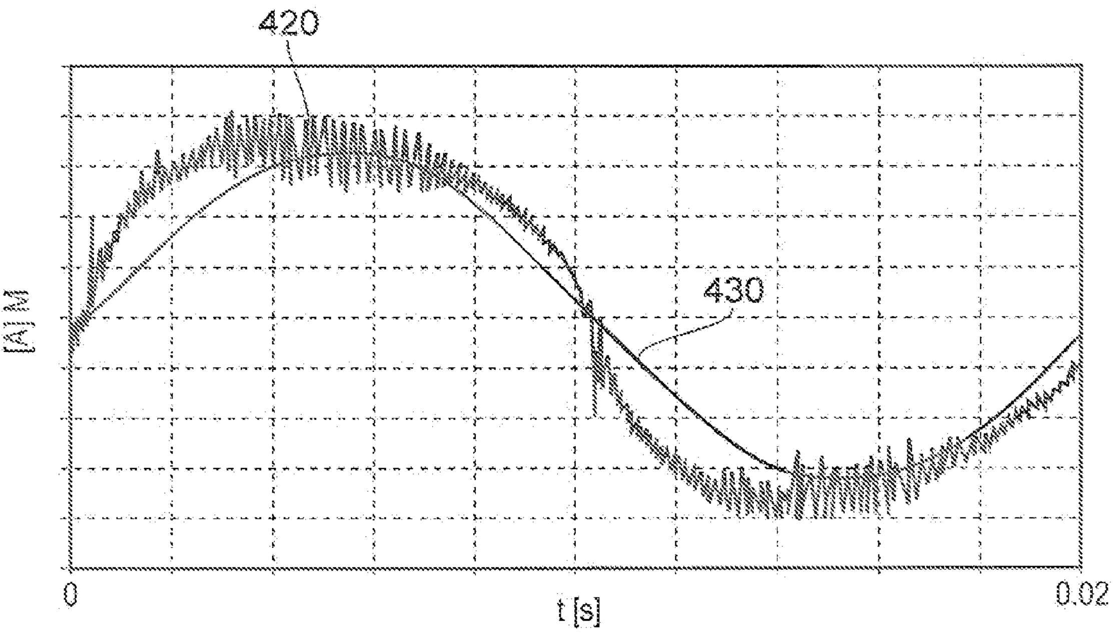
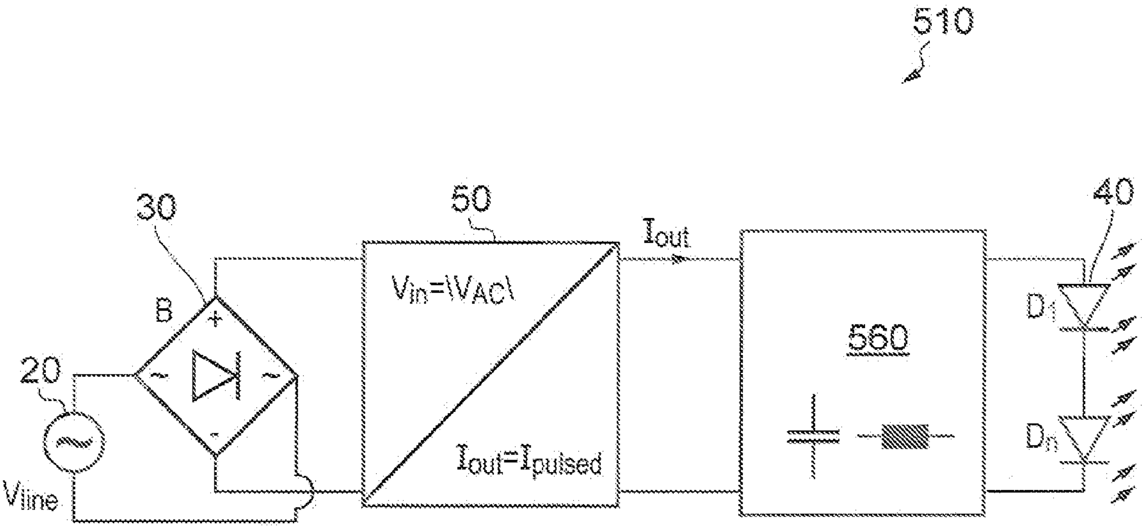
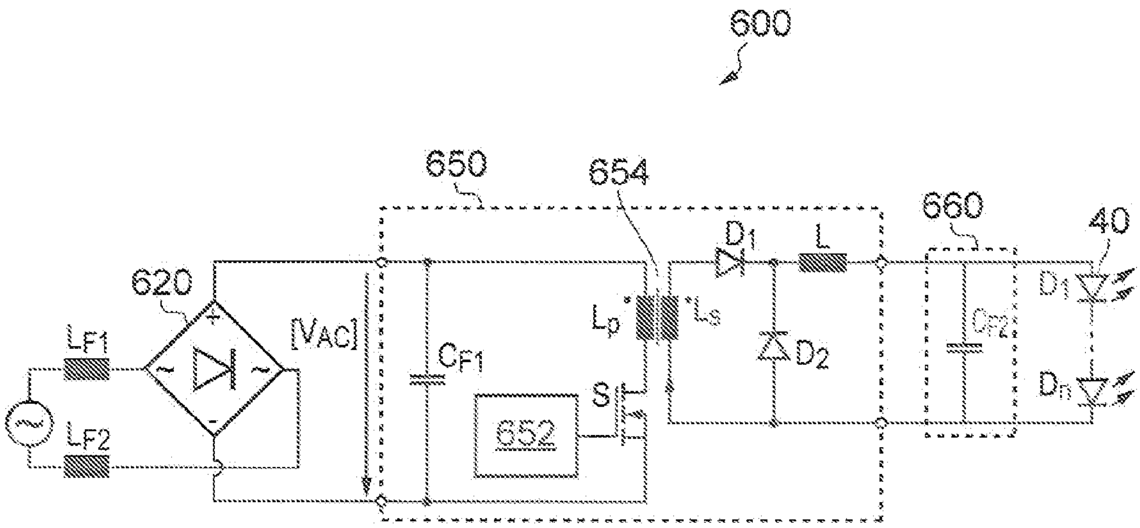

420
430
[A] M
0
t [s]
0.02

FIG. 4



510
30
50
40
B
20
Vin=|VAC|
Iout
560
D1
Dn
Vline
Iout=Ipulsed

FIG. 5



600
650
654
660
40
620
D1
L
D1
LF1
|VAC|
Lp
Ls
CF2
CF1
D2
S
Dn
LF2
652

FIG. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 10 0267

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2007/182338 A1 (SHTEYNBERG ANATOLY [US] ET AL) 9 August 2007 (2007-08-09) * paragraphs [0068], [0078], [0079], [0080]; figures 5,10 *	1-2,4-5, 8-11 3,6-7,12	INV. H05B33/08
X Y	WO 2008/112820 A2 (CIRRUS LOGIC INC [US]) 18 September 2008 (2008-09-18) * paragraph [0077]; figure 3 *	1,9-11 6-7,12	
X	US 2004/079953 A1 (MEDNIK ALEXANDER [US] ET AL) 29 April 2004 (2004-04-29) * claim 13; figure 7 *	1,8-11	
Y	WO 2008/068705 A1 (NXP BV [NL]; HOOGZAAD GIAN [NL]; MOBERS ANTONIUS M G [NL]) 12 June 2008 (2008-06-12) * figure 4 *	2-5,8	
Y	WO 2009/013676 A2 (NXP BV [NL]; HOOGZAAD GIAN [NL]) 29 January 2009 (2009-01-29) * page 13, line 28 - page 14, line 7 *	2-8	TECHNICAL FIELDS SEARCHED (IPC)
A	"HV9931 Unity Power Factor LED Lamp Driver, Initial realease" SUPERTEXT INC. HV 9931 - INITIAL RELEASE, SUPERTEX INC, SUNNYVALE, CA, USA, no. HV9931, 1 January 2005 (2005-01-01), pages 1-8, XP002486609 * figure Functional Circuit Diagram *	1-12	H05B
A	AN-H52 APPLICATION NOTE: "HV9931 Unity Power Factor LED Lamp Driver" 7 March 2007 (2007-03-07), SUPERTEXT INC.- AN-H52 - APPLICATION NOTE, SUPERTEX INC, SUNNYVALE, CA, USA, PAGE(S) 1 - 20 , XP002486610 * figures 1,5 *	1-12	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 October 2009	Müller, Uta

2

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 10 0267

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-10-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007182338 A1	09-08-2007	NONE	
WO 2008112820 A2	18-09-2008	US 7288902 B1 WO 2008112822 A2	30-10-2007 18-09-2008
US 2004079953 A1	29-04-2004	NONE	
WO 2008068705 A1	12-06-2008	NONE	
WO 2009013676 A2	29-01-2009	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82