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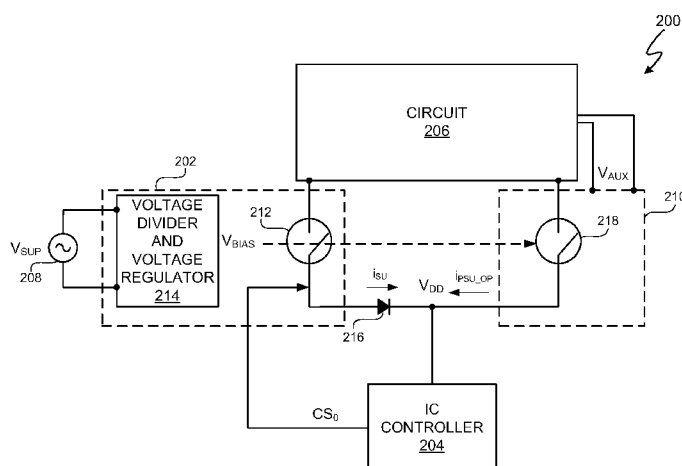


FIGURE 2

- (57) Abstract:** An electronic system (200) includes two power supplies (202, 210) to supply an operating (VDD) voltage to a switching power converter. The first power supply (202), referred to as a start-up power supply, includes a first source follower transistor (212) to conduct a start-up current for a controller (204) and supply an operating voltage for the controller. The controller controls operation of the switching power converter. A second power supply (210), referred to as an auxiliary power supply, includes a second source follower transistor (218) to conduct a steady-state operational current for the controller and supply an operating voltage for the controller. In at least one embodiment, once the second power supply begins supplying the operating voltage to the controller, the start-up power supply automatically ceases supplying the start-up current to the controller.

MULTIPLE POWER SOURCES FOR A SWITCHING POWER CONVERTER CONTROLLER

John L. Melanson

Eric J. King

CROSS-REFERENCE TO RELATED APPLICATION

[001] This application claims the benefit under 35 U.S.C. § 119(e) and 37 C.F.R. § 1.78 of U.S. Provisional Application No. 61/369,202, filed July 30, 2010, and entitled “LED Lighting Methods and Apparatuses” which is incorporated by reference in its entirety. This application also claims the benefit under 35 U.S.C. § 120 and 37 C.F.R. § 1.78 of U.S. of U.S. Patent Application No. 13/077,421, filed March 31, 2011, and entitled “Multiple Power Sources For A Switching Power Converter Controller” which is incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

[002] The present invention relates in general to the field of electronics, and more specifically to methods and systems of multiple power sources for a switching power converter controller.

DESCRIPTION OF THE RELATED ART

[003] Many systems utilize integrated circuit controllers. Each controller generally operates from an alternating current (AC) or direct current (DC) power source. In some embodiments a higher voltage source, such as a 60 Hz/110 V line voltage in the United States of America or a 50 Hz/220 V line voltage in Europe, is available to supply power to the controller. However, the voltage requirements of the controller are generally significantly less than the available line voltage. Thus, for efficiency, the controller often receives power from an auxiliary power supply that supplies a voltage that more closely matches the maximum voltage requirements of the controller. However, the auxiliary power supply often generates power from the line voltage source and, thus, cannot begin delivering start-up power to the controller instantaneously. Accordingly, many controllers receive start-up

power from the higher voltage source and fully or partially switch the auxiliary power source to deliver steady-state operating power.

[004] Figure 1 depicts an electronic system 100 that includes an IC controller 102 that controls delivery of power by switching power converter 104. Voltage source 106 supplies an alternating current (AC) input voltage V_{IN} to a full bridge diode rectifier 108. The voltage source 106 is, for example, a public utility, and the AC voltage V_{IN} is, for example, a 60 Hz/110 V line voltage in the United States of America or a 50 Hz/220 V line voltage in Europe. The full bridge rectifier 108 supplies a rectified AC voltage V_X to the switching power converter 104. Capacitor 110 filters high frequency components from rectified voltage V_X .

[005] Voltage source 112 supplies an initial start-up current i_{SU} and an operating voltage V_{DD} . Voltage source 112 includes resistor 114 and capacitor 116. Resistor 114 is connected between node 118 at rectified voltage V_X , and node 120 and supplies a current path for the initial start-up current i_{SU} . The initial start-up current i_{SU} charges capacitor 116, and capacitor 116 holds node 120 at a direct current (DC) operating voltage level V_{DD} .

[006] When node 120 reaches the operating voltage level V_{DD} , controller 102 begins controlling switching power converter 104. Switching power converter 104 is a boost-type power converter that boosts the rectified voltage V_X to generate a substantially DC link voltage V_{LINK} across link capacitor 122. Link capacitor 122 supplies current to energize the primary coil 123 of transformer 125 when FET switch 127 conducts. To control the switching power converter 104, controller 102 generates switch control signal C_0 to control the conduction state of a field effect transistor (FET) switch 124. When switch 124 conducts, the inductor current i_L energizes inductor 126. Diode 127 prevents link capacitor 122 from discharging through switch 124. When switch 124 stops conducting, inductor 126 discharges, and inductor current i_L replenishes the charge on link capacitor 122 to maintain the link voltage V_{LINK} at a substantially constant value. Controller 102 also generates switch control signal C_1 to control conductivity of switch 127, and, thus, control current flow into primary-side coil 123.

[007] Transformer 125 includes two secondary-side coils. When the controller 102 begins controlling switching power converter 104 and switching power converter 104 begins generating the link voltage V_{LINK} and energizing primary-side coil 123, secondary-side coil 128 supplies a load voltage V_{LD} across capacitor 130 to load 132. Diode 133 prevents

capacitor 130 from discharging through the secondary-side coil 128. Load 132 can be any type of load, such as a lighting system that includes any type of light source(s) such as one or more light emitting diodes (LEDs) or one or more fluorescent light sources, one or more motors, or one or more portable power sources.

[008] Electronic system 100 includes an auxiliary power supply 133 that supplies power to controller 102 during steady-state operation. The auxiliary power supply 133 includes auxiliary coil 134, and auxiliary coil 134 represents the other secondary-side coil of transformer 125. Auxiliary coil 134 energizes when secondary-side coil 128 begins energizing. Auxiliary coil develops a voltage equal to the operating voltage V_{DD} and supplies a post start-up, operating current i_{PSU_OP} to controller 102. The auxiliary power supply 133 also includes diode 136 and Zener diode 138. Diode 136 prevents reverse current flow into auxiliary coil 134, and Zener diode 138 maintains the voltage at node 120 at the operating voltage V_{DD} . In some embodiments of electronic systems 100, switching power converter 100 includes optional FET switch 140. Until the voltage across auxiliary coil 134 reaches the operating voltage V_{DD} , controller 102 generates switch control signal C_2 to cause switch 140 to conduct. When the voltage across auxiliary coil 134 reaches the operating voltage V_{DD} , controller 102 generates switch control signal C_2 to cause switch 140 to conduct and stop the start-up current i_{SU} through resistor 114.

[009] Electronic system 100 has several inefficiencies. For example, without switch 140, the start-up current i_{SU} continues to flow through resistor 114 when the auxiliary coil 134 is energized and supplying current i_{PSU_OP} . Current flow through resistor 114 generates power losses equal to the square of start-up current i_{SU} times the resistance value of resistor 114. If electronic system 100 includes switch 140, controller 102 includes extra, well-known complexity to generate the control signal C_2 . Additionally, switch 140 is generally a high voltage FET, which is more expensive than a low voltage FET.

SUMMARY OF THE INVENTION

[0010] In one embodiment of the present invention, an apparatus includes a first power supply having a first source follower transistor to conduct a start-up current for a controller and supply an operating voltage for the controller. The apparatus further includes a second power supply having a second source follower transistor to conduct a steady-state operational current for the controller and supply an operating voltage for the controller.

[0011] In another embodiment of the present invention, a method includes supplying a start-up current for a controller and supplying an operating voltage for the controller from a first power supply having a first source follower transistor to conduct the start-up current. The method further includes supplying a steady-state operational current for the controller and supplying an operating voltage for the controller from a second power supply having a second source follower transistor to conduct the steady-state operational current.

[0012] In a further embodiment of the present invention, an apparatus includes a switching power converter and a controller coupled to the switching power converter to control operation of the switching power converter. The apparatus also includes a first power supply having a first source follower transistor to conduct a start-up current for the controller and supply an operating voltage for the controller. The apparatus further includes a second power supply having a second source follower transistor to conduct a steady-state operational current for the controller and supply an operating voltage for the controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention may be better understood, and its numerous objects, features and advantages made apparent to those skilled in the art by referencing the accompanying drawings. The use of the same reference number throughout the several figures designates a like or similar element.

[0014] Figure 1 (labeled prior art) depicts an electronic system having two voltage sources for supplying power to a switching power converter controller.

[0015] Figure 2 depicts an electronic system having two voltage sources with source-follower transistors for supplying power to a switching power converter controller.

[0016] Figure 3 depicts an embodiment of the electronic system of Figure 2.

[0017] Figure 4 depicts an embodiment of a transformer for use in the electronic system of Figure 3.

[0018] Figure 5 depicts exemplary, superimposed operating voltage waveforms for the electronic system of Figure 3.

DETAILED DESCRIPTION

[0019] An electronic system includes two power supplies to supply an operating voltage to a switching power converter. The first power supply, referred to as a start-up power supply, includes a first source follower transistor to conduct a start-up current for a controller and supply an operating voltage for the controller. The controller controls operation of the switching power converter. A second power supply, referred to as an auxiliary power supply, includes a second source follower transistor to conduct a steady-state operational current for the controller and supply an operating voltage for the controller. In at least one embodiment, once the second power supply begins supplying the operating voltage to the controller, the start-up power supply automatically ceases supplying the start-up current to the controller. Thus, in at least one embodiment, components of the start-up power supply do not dissipate power and, therefore, do not present power losses in the electronic system during steady state operation.

[0020] In at least one embodiment, the controller controls a source of the first source follower transistor to control the switching power converter. In at least one embodiment, the first and second source follower transistors are field effect transistors, and the gates of the first and second FET transistors are biased by the same gate voltage. In at least one embodiment, the second transistor is a low voltage FET, and the controller controls operation of the second transistor to regulate the operating voltage. In at least one embodiment, the second transistor is more efficient than a conventional Zener diode that regulates an operating voltage.

[0021] DEFINITION. A source follower transistor is a transistor whose conductivity is controlled by a feature of the transistor that supplies electrons. For example, a FET includes gate, drain, and source features. The FET is a source follower when a bias of the source of the FET controls conductivity of the FET. For example, a bipolar junction transistor (BJT) includes base, collector, and emitter features. In at least one embodiment, the BJT is a source follower when a bias of the emitter of the BJT controls conductivity of the BJT.

[0022] Figure 2 depicts an electronic system 200 having a start-up power supply 202 to supply power to integrated circuit (IC) controller 204 during start-up of the controller 204. “Start-up” is a phase of the operation of controller 204 during which controller 204 initializes and begins to operate and control circuit 206. In at least one embodiment, circuit 206 is a switching power converter, such as a boost converter, buck converter, boost-buck converter,

or a Cúk converter. The start-up power supply 202 receives power from a voltage supply 208 that supplies a supply voltage V_{SUP} . Voltage supply 208 can be any type of AC or DC voltage supply. In at least one embodiment, voltage supply 208 is a rectified line voltage source that generates a voltage identical to rectified voltage V_X of Figure 1. In at least one embodiment, voltage supply 208 is a battery.

[0023] Electronic system 200 also includes an auxiliary power supply 210 to supply power to controller 204 during post start-up operations of controller 204. “Post start-up operations” of controller 204 can also be referred to as “steady state” operations and refer to a phase of the operation of controller 204 when controller 204 is controlling circuit 206 and auxiliary power supply 210 is able to obtain a sufficient auxiliary operating voltage V_{AUX} from circuit 206 to supply an operating voltage V_{DD} to controller 204.

[0024] During start-up of controller 204, voltage supply 208 begins supplying the supply V_{SUP} to start-up power supply 202. Start-up power supply 202 includes a source follower transistor 212, such as a FET or BJT. During start-up of controller 204, voltage divider and voltage regulator 214 and source follower transistor 212 conduct a start-up current i_{SU} through diode 216 and supply the operating voltage V_{DD} to controller 204. The voltage divider and voltage regulator 214 step down the supply voltage V_S to bias source follower transistor 212 with the voltage V_{BIAS} . During post start-up operations, controller 204 generates a control signal CS_0 to control a source of source follower transistor 212 to control operation of circuit 206. An exemplary controller to control the source follower transistor 212 is described in U.S. Patent Application No. 12/496,457, filed on June 30, 2009, entitled *Cascode Configured Switching Using At Least One Low Breakdown Voltage Internal, Integrated Circuit Switch To Control At Least One High Breakdown Voltage External Switch*, inventor John L. Melanson, and assignee Cirrus Logic, Inc. U.S. Patent Application No. 12/496,457, referred to herein as Melanson I, is hereby incorporated by reference in its entirety. In at least one embodiment, the gates of FET based source follower transistors 212 and 218 share a common bias voltage V_{BIAS} and, in at least one embodiment, are connected together. In at least one embodiment, the bases of BJT based source follower transistors 212 and 218 also share a common bias voltage V_{BIAS} and, in at least one embodiment, are connected together.

[0025] When controller 204 begins to control circuit 206, circuit 206 supplies an auxiliary voltage V_{AUX} to auxiliary power supply 210. Auxiliary power supply 210 also includes a

source follower transistor 218 to conduct a steady state, post start-up operating current i_{PSU_OP} and supply the operating voltage V_{DD} to controller 204. In at least one embodiment, once the auxiliary power supply 210 begins supplying the operating voltage V_{DD} to the controller 204, the start-up power supply 202 ceases supplying the start-up current i_{SU} to the controller 204. By ceasing operation, start-up power supply 202 prevents any power losses that can occur during operation of start-up power supply 202.

[0026] Figure 3 depicts an electronic system 300, which represents one embodiment of electronic system 200. As subsequently described in more detail, electronic system 300 includes a start-up power supply 302, which includes a source follower FET 304, to conduct a start-up current i_{SU} for a controller 306 and supply an operating voltage V_{DD} for the controller 306. Electronic system 300 also includes an auxiliary power supply 308, which includes a source follower FET 310, to conduct a steady-state operational current i_{PSU_OP} for the controller 306 and, in at least one embodiment, regulate the operating voltage V_{DD} for the controller 306. In at least one embodiment, controller 306 is identical controller 204.

[0027] Voltage source 106, rectifier 108, and capacitor 110 function as described with reference to Figure 1 to generate the rectified voltage V_X . Capacitors 312 and 314 establish a voltage divider to set a gate bias voltage V_g for FET 304. In at least one embodiment, the particular capacitance values of capacitors 312 and 314 are a matter of design choice. In at least one embodiment, the capacitance of capacitor 312 is 22-47 nF, and the capacitance of capacitor 314 is 47 nF. Resistor 313 has a resistance in the range of, for example, 1 kohm to 20 kohm. Resistor 313 shapes the start-up current i_{SU} charging capacitor 314 and limits peak start-up current i_{SU} . Diode 316 prevents the gate current i_g from being conducted to the voltage reference V_{REF} , such as a ground reference. The gate current i_g is conducted through diode 318, which prevents reverse current flow of the gate current i_g , to the gate of source follower FET 304. Zener diode 320 clamps the gate of source follower FET 304 to the gate voltage V_g .

[0028] The gate bias voltage V_g minus the source voltage V_S of FET 304 exceeds a threshold voltage of FET 304. FET 304 conducts the start-up current i_{SU} through resistor 324, FET 304, and diode 326 to charge capacitor 328 to the operating voltage V_{DD} . The capacitance of capacitor 328 is, for example, 10 μ F. At start-up, the operating voltage V_{DD} across capacitor 328 equals the Zener voltage V_Z minus the threshold voltage V_{T304} of FET 304 minus the diode voltage V_d across diode 326, i.e. at start-up $V_{DD} = V_Z - V_{T304} - V_d$. FET

304 is a high voltage FET that is used to control boost-type switching power converter 330, and the threshold voltage V_{T304} of FET 304 is, for example, approximately 3V. FET 304 is included in both the start-up power supply 302 and switching power converter 330.

[0029] When the voltage at node 332 reaches the operating voltage V_{DD} , controller 306 initializes and begins generating the switch control signal CS_0 as described in, for example, Melanson I. Once controller 306 begins generating switch control signal CS_0 , switching power converter 330 generates the link voltage V_{LINK} across link capacitor 122 as described with reference to switching power converter 104 (Figure 1).

[0030] The link voltage V_{LINK} energizes the primary-side coil 332 of transformer 334 and induces a load voltage V_{LD} via secondary-side coil 128 for load 132 as described with reference to the electronic system 100 (Figure 1). The primary-side coil 332 also induces an auxiliary voltage V_{AUX} in secondary-side coil 336. The auxiliary voltage V_{AUX} causes the steady state, post start-up operating current i_{PSU_OP} to flow through diode 338 and source follower FET 310 to capacitor 328. The gates of FETs 304 and 310 are connected together. Thus, once FET 310 begins conducting, controller 306 enters post-start-up operation, and the operating voltage V_{DD} equals the Zener voltage V_Z minus the threshold voltage V_{T310} , i.e. during post start-up operation, $V_{DD} = V_Z - V_{T310}$. Source follower-FET 310 is a low voltage FET, and, thus, the threshold voltage V_{T310} is less than the threshold voltage V_{T304} of source follower FET 304. The threshold voltage V_{T310} is, for example, approximately 2V, and, as previously mentioned, the threshold voltage V_{T304} of FET 304 is, for example, approximately 3V. Thus, the ratio of V_{T310} to V_{T304} is, in at least one embodiment, 2:3. Since the gates of FETs 304 and 310 are connected and biased by gate V_g , during post start-up operation, $V_{DD} > V_Z - (V_{T304} - V_d)$, start-up power supply 302 ceases operation, and the start-up current i_{SU} ceases.

[0031] During post start-up operation, FET 310 has a source-drain energy loss. However, the source-drain loss of FET 310 is generally less than an energy loss of Zener diode 138 (Figure 1). Additionally, in at least one embodiment, electronic system 300 does not have a high voltage FET, such as FET 140, to shut off start-up power supply 302 once the auxiliary power supply 308 begins supplying the steady state, post start-up operating current i_{PSU_OP} and supplying the operating voltage V_{DD} . Since the auxiliary voltage V_{AUX} is a lower voltage than the supply voltage V_{SUP} , supplying the operating voltage V_{DD} from the auxiliary

voltage V_{AUX} is more efficient than supplying the operating voltage from the rectified supply voltage V_X .

[0032] Figure 4 depicts transformer 400. Transformer 400 generates the auxiliary voltage V_{AUX} using a primary side coil 402. Transformer 400 can be substituted for transformer 334 in electronic system 300 (Figure 3). Substituting transformer 400 for transformer 334 allows the primary-side coil 133 to transfer energy to the secondary-side coil 128 without transferring energy to the auxiliary coil 404 and, thus, taking power from the load 132.

[0033] Figure 5 depicts exemplary, superimposed operating voltage waveforms for electronic system 300. Referring to Figures 3 and 5, at time t_0 , the rectified voltage V_X activates, and the start-up current i_{SU} generated by start-up power supply 302 causes the gate voltage V_g to cause FET 304 to conduct. Once FET 304 begins conducting at time t_0 , capacitor 328 begins charging from time t_0 to time t_1 to raise the voltage at node 332 to operating voltage V_{DD} . Between times t_1 and t_2 , controller 306 begins controlling switching power converter 330. At time t_2 , the switching power converter 330 generates the auxiliary voltage V_{AUX} . The auxiliary voltage V_{AUX} then causes steady state, post start-up operating current i_{PSU_OP} to flow to node 332 and maintain the voltage across capacitor 328 at the operating voltage V_{DD} . Also at time t_2 , the source voltage V_S of FET 304 rises, thus causing the start-up current i_{SU} to stop flowing and start-up power supply 302 to cease operation. The controller 306 then controls the source voltage V_S of FET 304 to control operation of the switching power converter 330 as, for example, described in Melanson I.

[0034] Thus, a start-up power supply and an auxiliary power supply each include source follower transistors to supply an operating voltage V_{DD} and respectively supply a start-up current and a steady state, post start-up operating current. During post start-up operation, the start-up power supply ceases operation, thus, reducing losses associated with the start-up power supply. Additionally, in at least one embodiment, the start-up power supply does not include a high voltage FET, thus, reducing cost. Additionally, in at least one embodiment, the auxiliary power supply includes a low voltage FET that incurs smaller energy losses than a conventional Zener diode.

[0035] Although embodiments have been described in detail, it should be understood that various changes, substitutions, and alterations can be made hereto without departing from the spirit and scope of the invention as defined by the appended claims.

WHAT IS CLAIMED IS:

- 1 1. An apparatus comprising:
2 a first power supply having a first source follower transistor to conduct a start-up
3 current for a controller and supply an operating voltage for the controller; and
4 a second power supply having a second source follower transistor to conduct a steady-
5 state operational current for the controller and supply an operating voltage for
6 the controller.
- 1 2. The apparatus of claim 1 wherein the first and second source follower
2 transistors are field effect transistors.
- 1 3. The apparatus of claim 2 wherein a gate of the first transistor is connected to a
2 gate of the second transistor.
- 1 4. The apparatus of claim 1 wherein first and second transistors are bipolar
2 junction transistors.
- 1 5. The apparatus of claim 1 further comprising:
2 a switching power converter; and
3 the controller, coupled to the switching power converter, to control a source of the
4 first source follower transistor to control operation of the switching power
5 converter.
- 1 6. The apparatus of claim 1 wherein the first power supply includes a voltage
2 divider to supply an operational voltage to the controller during a start-up period of the
3 controller.
- 1 7. The apparatus of claim 6 wherein the voltage divider comprises a plurality of
2 series coupled capacitors.

1 8. The apparatus of claim 1 wherein the second power supply comprises an
2 auxiliary winding of a transformer.

1 9. The apparatus of claim 1 wherein when the second power supply supplies the
2 operating voltage to the controller, the first power supply automatically ceases supplying the
3 start-up current to the controller.

1 10. The apparatus of claim 1 wherein the second source follower transistor
2 regulates the operating voltage supplied to the controller from the second power supply.

1 11. An method comprising:
2 supplying a start-up current for a controller and supplying an operating voltage for the
3 controller from a first power supply having a first source follower transistor to
4 conduct the start-up current; and
5 supplying a steady-state operational current for the controller and supplying an
6 operating voltage for the controller from a second power supply having a
7 second source follower transistor to conduct the steady-state operational
8 current.

1 12. The method of claim 11 wherein the first and second source follower
2 transistors are field effect transistors.

1 13. The method of claim 12 wherein a gate of the first transistor is connected to a
2 gate of the second transistor.

1 14. The method of claim 11 wherein first and second transistors are bipolar
2 junction transistors.

1 15. The method of claim 11 further comprising:
2 controlling a source of the first source follower transistor to control operation of a
3 switching power converter.

- 1 16. The method of claim 11 further comprising:
2 supplying an operational voltage to the controller during a start-up period of the
3 controller using a voltage divider to divide a supply voltage supplied to the
4 first power supply.
- 1 17. The method of claim 16 wherein the voltage divider comprises a plurality of
2 series coupled capacitors.
- 1 18. The method of claim 11 wherein supplying a steady-state operational current
2 for the controller and supplying an operating voltage for the controller from a second power
3 supply comprises:
4 receiving an auxiliary supply voltage from an auxiliary winding of a transformer.
- 1 19. The method of claim 11 further comprising:
2 automatically ceasing supplying the start-up current to the controller from the first
3 power supply when the second power supply supplies the operating voltage to
4 the controller.
- 1 20. The method of claim 11 further comprising:
2 regulating the operating voltage supplied for the controller from the second power
3 supply with the second source follower transistor.
- 1 21. An apparatus comprising:
2 a switching power converter,
3 a controller coupled to the switching power converter to control operation of the
4 switching power converter;
5 a first power supply having a first source follower transistor to conduct a start-up
6 current for the controller and supply an operating voltage for the controller;
7 and

8 a second power supply having a second source follower transistor to conduct a steady-
9 state operational current for the controller and supply an operating voltage for
10 the controller.

1 22. The apparatus of claim 21 further comprising a load coupled to the switching
2 power converter.

1 23. The apparatus of claim 22 wherein the load comprises one or more members
2 of a group consisting of one or more light emitting diodes, one or more fluorescent light
3 sources, one or more motors, and one or more portable power sources.

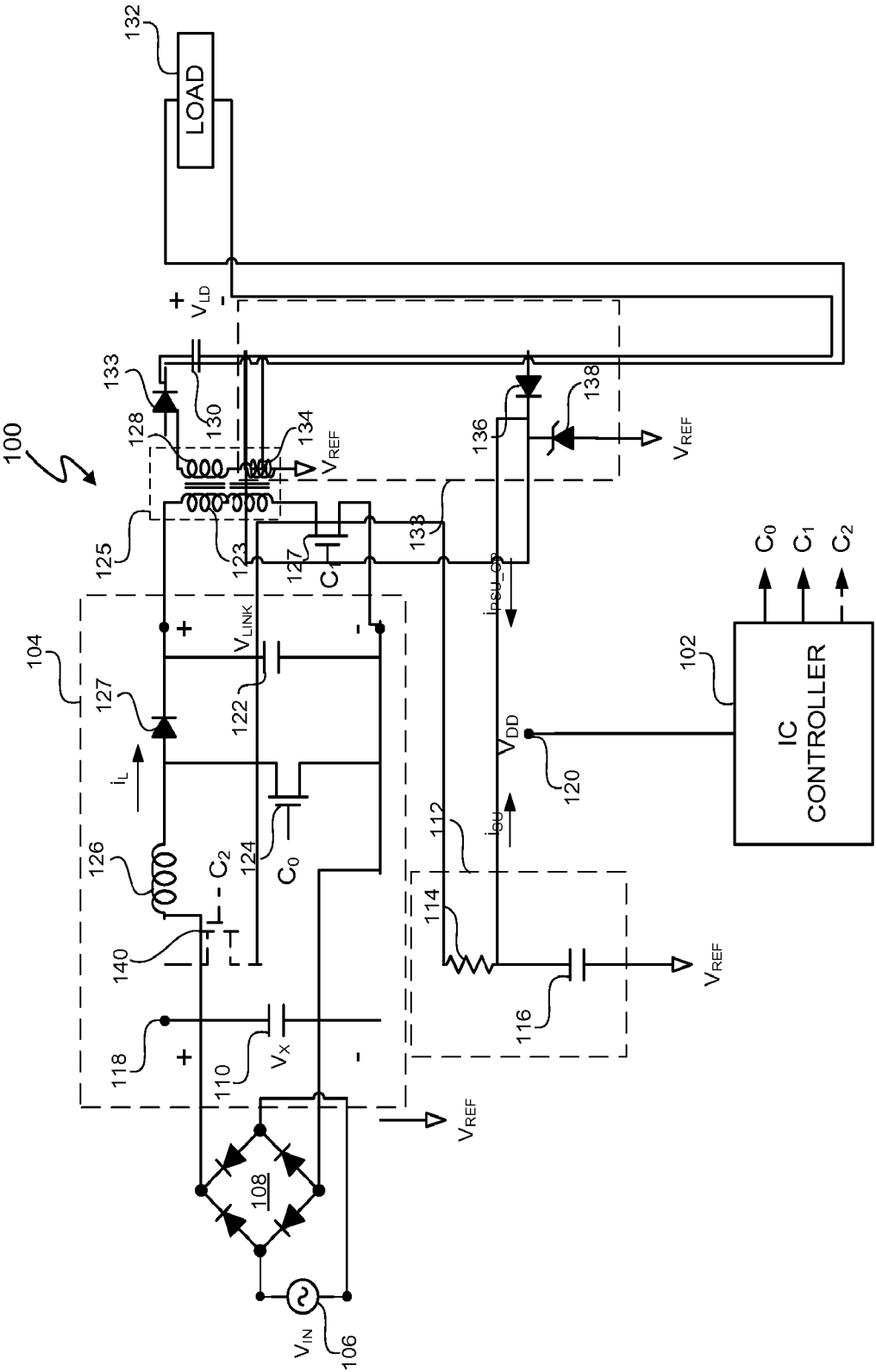


FIGURE 1 (PRIOR ART)

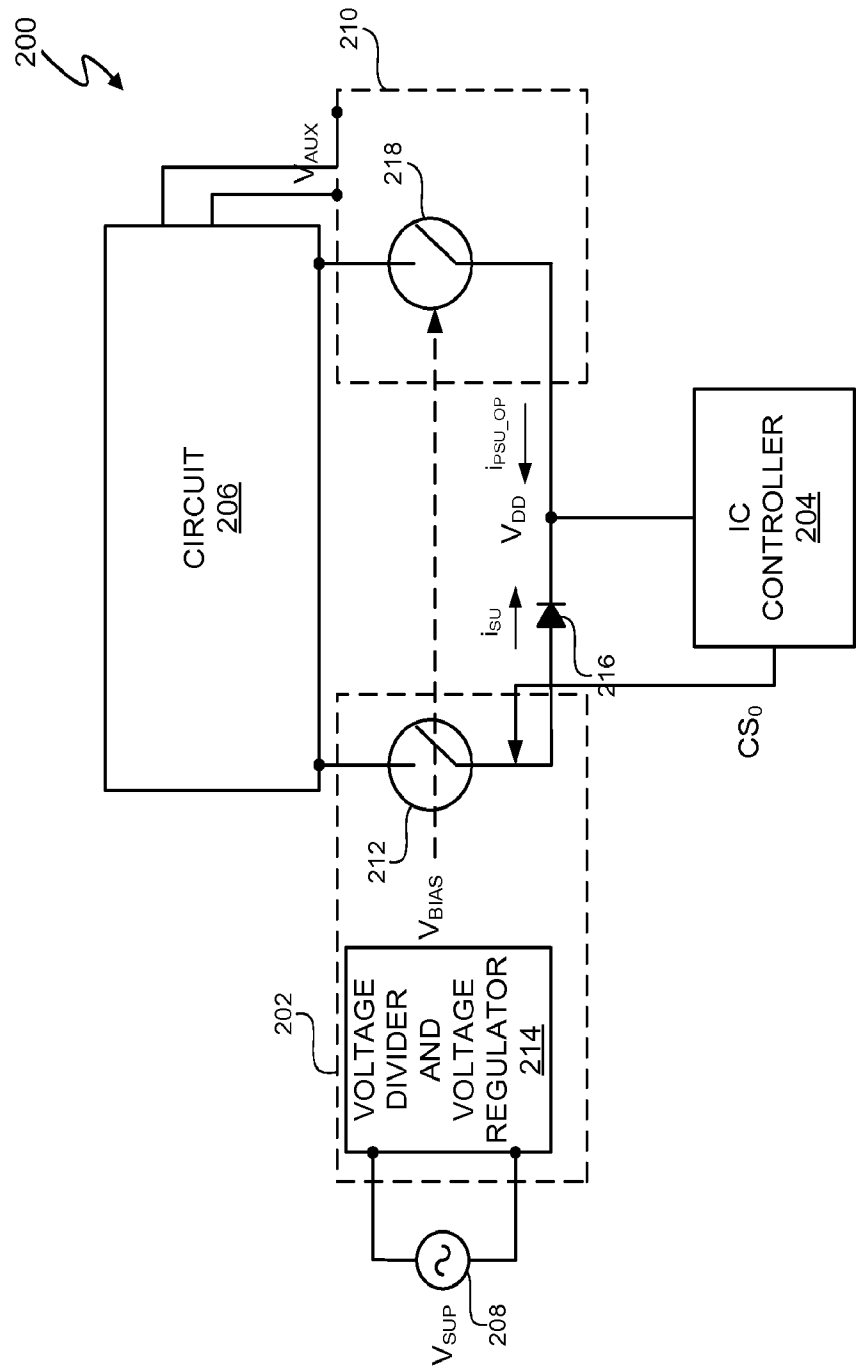


FIGURE 2

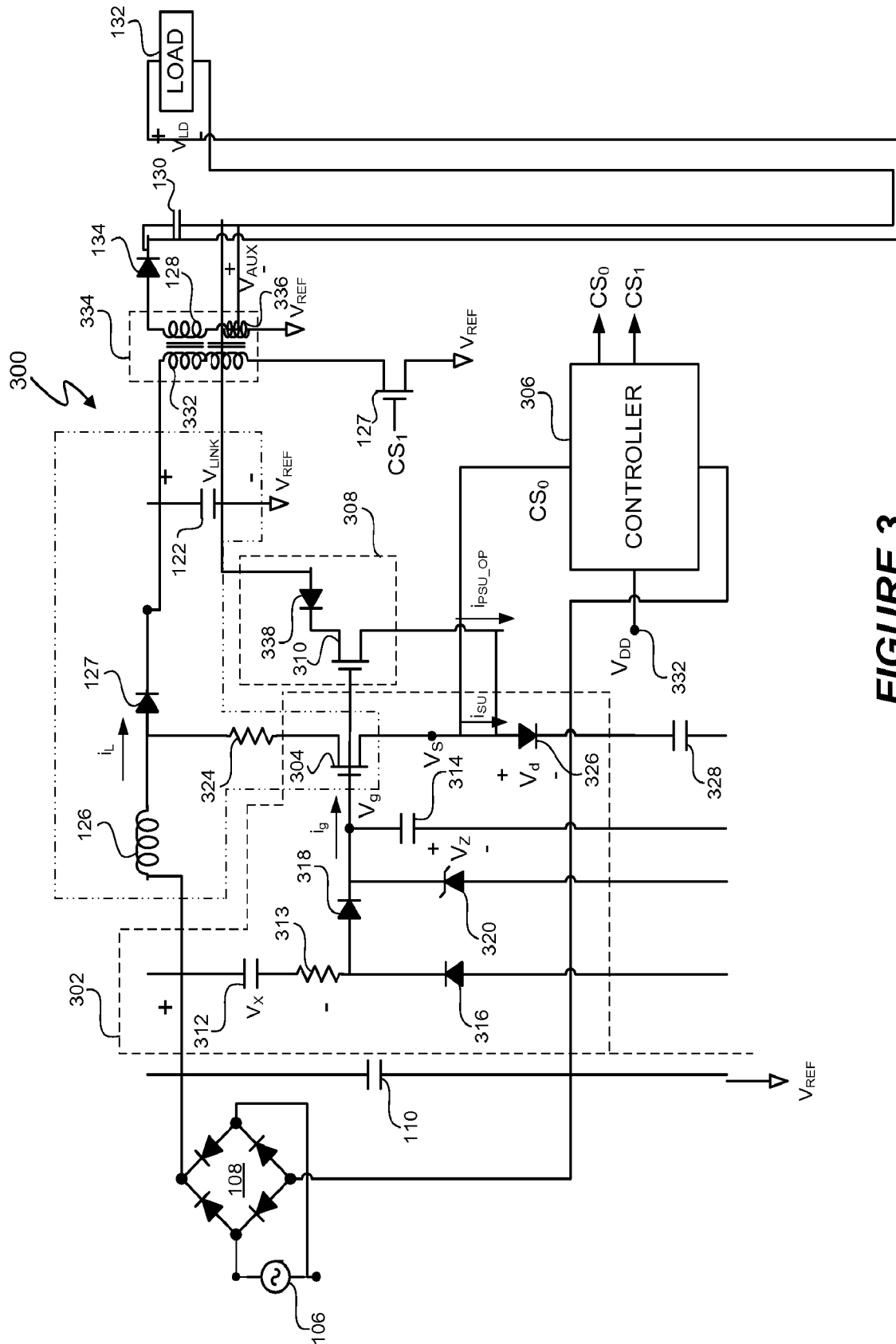
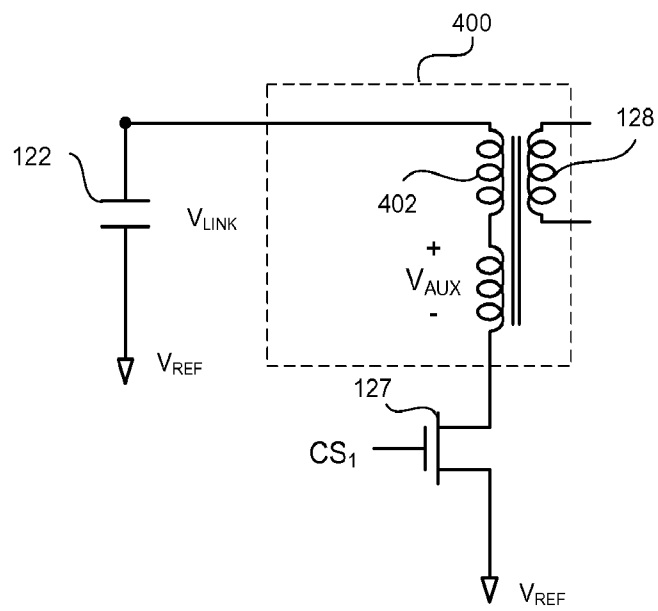
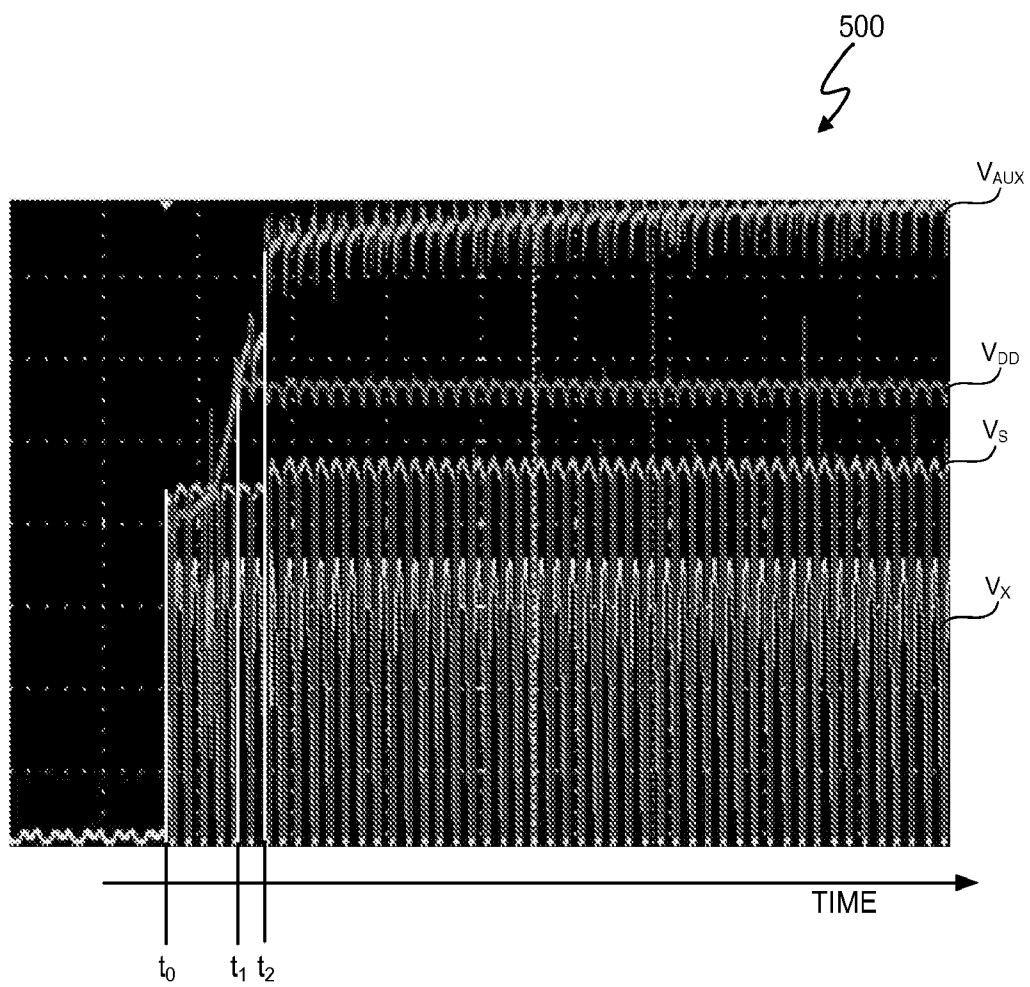


FIGURE 3

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**FIGURE 4**

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**FIGURE 5**

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2011/046002

A. CLASSIFICATION OF SUBJECT MATTER

INV. H02M1/36

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/101098 A1 (DISNEY DONALD R [US]) 1 May 2008 (2008-05-01) abstract figure 2 paragraph [0007] -----	1-23
X	US 2009/135632 A1 (SOHMA SHOHTAROH [JP]) 28 May 2009 (2009-05-28) abstract figure 3 paragraphs [0035], [0040], [0043], [0048], [0053], [0054] -----	1-7, 10-17, 20-23 8,9,18, 19
A		



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Information on patent family members

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