

CLAIMS

What is claimed is:

1. A light emitting diode (LED) driver receiving an input voltage, driving a first and a second LED modules, and comprising:

a compensation capacitor set including a first and a second capacitors electrically connected to each other in series, wherein the first capacitor is electrically connected to the first and the second LED modules, the second capacitor is grounded, and the compensation capacitor set provides a compensation voltage to the first and the second LED modules when an instantaneous voltage value of the input voltage is lower than an LED conduction voltage such that the first and the second LED modules are conductible;

an overvoltage protection and energy recovery circuit, including:

an energy recovery circuit, including:

a third capacitor having a first and a second terminals; and

a first diode having an anode and a cathode, wherein the anode of the first diode is electrically connected to the first terminal of the third capacitor, the second terminal of the third capacitor is grounded, the cathode of the first diode is electrically connected to the first and the second LED modules, and a stored energy in the third capacitor is released to the first and the second LED modules when a cross voltage between the first and the second terminals of the third capacitor is larger than a cross voltage of the compensation capacitor set; and

a segmental current-limiting circuit, including:

a first voltage divider electrically connected to the compensation capacitor set in parallel and having a first midpoint;

a first current limiting circuit, including:

a second diode having an anode and a cathode;

a first resistor having a first and a second terminals, wherein the first terminal of the first resistor is electrically connected to the anode of the second diode, and the second terminal of the first resistor is grounded;

a first transistor having a first terminal, a second terminal and a control terminal, wherein the first terminal of the first transistor is electrically connected to the first and the second LED modules, the second terminal of the first transistor is electrically connected to the first terminal of the first resistor, and the control terminal of the first transistor is electrically connected to the first midpoint of the first voltage divider; and

a second transistor having a first terminal, a second terminal and a control terminal, wherein the first terminal of the second transistor is electrically connected to the second terminal of the first transistor, the second terminal of the second transistor is grounded, and the control terminal of the second transistor is electrically connected to the cathode of the second diode; and

an input voltage detection circuit electrically connected to the compensation capacitor set in parallel and including a second midpoint electrically connected to the control terminal of the second transistor, wherein the second midpoint has a voltage value used to determine whether the LED driver enters a segmental conduction mode.

2. A driver according to Claim 1, wherein the overvoltage protection and energy recovery circuit further includes an overvoltage protection circuit, including:

a second voltage divider electrically connected to the compensation capacitor set in parallel and having a third midpoint;

a second current limiting circuit, including:

a third diode having an anode and a cathode;

a second resistor having a first and a second terminals, wherein the first terminal of the second resistor is electrically connected to the anode of the third diode, and the second terminal of the second resistor is grounded;

a third transistor having a first terminal, a second terminal and a control terminal, wherein the first terminal of the third transistor is electrically connected to the second LED module, the second terminal of the third transistor is electrically connected to the first terminal of the second resistor, and the control terminal of the

third transistor is electrically connected to the third midpoint of the second voltage divider;

a fourth transistor having a first terminal, a second terminal and a control terminal, wherein the input voltage detection circuit further includes a fourth midpoint, the first terminal of the fourth transistor is electrically connected to the control terminal of the third transistor, the second terminal of the fourth transistor is grounded, the control terminal of the fourth transistor is electrically connected to the cathode of the third diode and the fourth midpoint of the input voltage detection circuit, and a voltage value of the fourth midpoint is used to determine whether the LED driver switches into an overvoltage protection mode; and

a fourth diode having an anode and a cathode, wherein the anode of the fourth diode is electrically connected to the first terminal of the third transistor and the cathode of the fourth diode is electrically connected to the first terminal of the third capacitor.

3. A driver according to Claim 2, further comprising an AC input power source and a rectifier having a first and a second input terminals and a first and a second output terminals, wherein each of the first and the second capacitors has a first and a second terminals, the rectifier is electrically connected to the AC input power source at the first and the second input terminals, the second input terminal of the rectifier is electrically connected to the second terminal of the first capacitor and the first terminal of the second capacitor, the first output terminal of the rectifier is electrically connected to the first terminal of the first capacitor, and the second output terminal of the rectifier is grounded and is electrically connected to the second terminal of the second capacitor.

4. A driver according to Claim 3, wherein the first voltage divider further comprises a third and a fourth resistors electrically connected to the first midpoint, the second voltage divider further comprises a fifth and a sixth resistors electrically connected to

the third midpoint, the input voltage detection circuit further comprises a seventh to a ninth resistors, the seventh and the eighth resistors are electrically connected to the second midpoint, the eighth and the ninth resistors are electrically connected to the fourth midpoint, the driver enters the segmental conduction mode when one of the input voltage and a voltage value of the second midpoint is not larger than a predetermined value, the driver enters the overvoltage protection mode when one of the input voltage and a voltage value of the fourth midpoint is larger than the predetermined value, and when the cross voltage of the third capacitor is larger than the cross voltage of the compensation capacitor set, the stored energy of the third capacitor is released to the first and the second LED modules via the third diode.

5. A light emitting diode (LED) driver receiving an input voltage, driving a first and a second LED modules, and comprising:

- a compensation capacitor set including a first and a second capacitors electrically connected to each other in series, wherein the first capacitor is electrically connected to the first and the second LED modules, the second capacitor is grounded, and the compensation capacitor set provides a compensation voltage to the first and the second LED modules when an instantaneous voltage value of the input voltage is lower than an LED conduction voltage such that the first and the second LED modules are conductible; and

- a segmental current-limiting circuit, including:

- a voltage divider electrically connected to the compensation capacitor set in parallel and having a first midpoint;

- a current limiting circuit, including:

- a first diode having an anode and a cathode;

- a first resistor having a first and a second terminals, wherein the first terminal of the first resistor is electrically connected to the anode of the first diode, and the second terminal of the first resistor is grounded;

a first transistor having a first terminal, a second terminal and a control terminal, wherein the first terminal of the first transistor is electrically connected to the first and the second LED modules, the second terminal of the first transistor is electrically connected to the first terminal of the first resistor, and the control terminal of the first transistor is electrically connected to the first midpoint of the voltage divider; and

a second transistor having a first terminal, a second terminal and a control terminal, wherein the first terminal of the second transistor is electrically connected to the second terminal of the first transistor, the second terminal of the second transistor is grounded, and the control terminal of the second transistor is electrically connected to the cathode of the first diode; and

an input voltage detection circuit electrically connected to the compensation capacitor set in parallel and including a second midpoint, wherein the second midpoint is electrically connected to the control terminal of the second transistor, and a voltage value of the second midpoint is used to determine whether the LED driver switches into an overvoltage protection mode.

6. A driver according to Claim 5, further comprising an AC input power source and a rectifier having a first and a second input terminals and a first and a second output terminals, wherein each of the first and the second capacitors has a first and a second terminals, the rectifier is electrically connected to the AC input power source at the first and the second input terminals, the second input terminal of the rectifier is electrically connected to the second terminal of the first capacitor and the first terminal of the second capacitor, the first output terminal of the rectifier is electrically connected to the first terminal of the first capacitor, and the second output terminal of the rectifier is grounded and is electrically connected to the second terminal of the second capacitor.

7. A driver according to Claim 6, wherein the voltage divider further comprises a second and a third resistors electrically connected to each other at the first midpoint in series, and the input voltage detection circuit further comprises a fourth and a fifth resistors electrically connected to each other at the second midpoint in series.

8. A light emitting diode (LED) driver receiving an input voltage, driving an LED, and comprising:

a compensation capacitor set including a first and a second capacitors electrically connected to each other in series, wherein the first capacitor is electrically connected to the LED, the second capacitor is grounded, and the compensation capacitor set provides a compensation voltage to the LED when an instantaneous voltage value of the input voltage is lower than an LED conduction voltage such that the LED is conductible.

9. A driver according to Claim 8, further comprising an AC input power source, an inductor having a first and a second terminals, and a rectifier having a first and a second input terminals and a first and a second output terminals, wherein the LED includes an anode and a cathode, the AC input power source is electrically connected to the first terminal of the inductor and the second input terminal of the rectifier, the second terminal of the inductor is electrically connected to the first input terminal of the rectifier, the second input terminal of the rectifier is electrically connected to the second terminal of the first capacitor and the first terminal of the second capacitor, the first output terminal of the rectifier is electrically connected to the first terminal of the first capacitor and the anode of the LED, and the second output terminal of the rectifier is grounded and electrically connected to the second terminal of the second capacitor and the cathode of the LED.

10. A driver according to Claim 8, further comprising an overvoltage protection and energy recovery circuit, including:

an energy recovery circuit, including:

a third capacitor having a first and a second terminals; and

a first diode having an anode and a cathode, wherein the anode of the first diode is electrically connected to the first terminal of the third capacitor, the second terminal of the third capacitor is grounded, the cathode of the first diode is electrically connected to the LED, and a stored energy in the third capacitor is released to the LED when a cross voltage between the first and the second terminals of the third capacitor is larger than a cross voltage of the compensation capacitor set;

a voltage divider electrically connected to the compensation capacitor set in parallel and having a first midpoint;

an overvoltage protection circuit, including:

a first transistor having a first terminal, a second terminal and a control terminal, wherein the first terminal of the first transistor is electrically connected to the LED, and the second terminal of the first transistor is grounded; and

a second transistor having a first terminal, a second terminal and a control terminal, wherein the first terminal of the second transistor is electrically connected to the control terminal of the first transistor and the first midpoint, and the second terminal of the second transistor is grounded; and

an input voltage detection circuit electrically connected to the voltage divider in parallel and including a second midpoint electrically connected to the control terminal of the second transistor.

11. A driver according to Claim 10, further comprising an AC input power source, an inductor having a first and a second terminals, and a rectifier having a first and a second input terminals and a first and a second output terminals, wherein the LED includes an anode and a cathode, the overvoltage protection circuit further includes a second diode having an anode and a cathode, the anode of the second diode is electrically connected to the first terminal of the first transistor, and the cathode of the second diode is electrically connected to the first terminal of the third capacitor.

12. A driver according to Claim 11, wherein the voltage divider further includes a first and a second resistors, each of which has a first and a second terminals, the first terminal of the first resistor is electrically connected to the anode of the LED, the first terminal of the second resistor is electrically connected to the second terminal of the first resistor and the first terminal of the third resistor, the second terminal of the second resistor is grounded, the second terminal of the third resistor is electrically connected to the first midpoint, the input voltage detection circuit further comprises a fourth and a fifth resistors, each of which has a first and a second terminals, the second terminal of the fourth resistor is electrically connected to the first terminal of the fifth resistor at the second midpoint, the second terminal of the fifth resistor is grounded, the AC input power source is electrically connected to the first terminal of the inductor and the second input terminal of the rectifier, the second terminal of the inductor is electrically connected to the first input terminal of the rectifier, each of the first and the second capacitors has a first and a second terminals, the second input terminal of the rectifier is electrically connected to the second terminal of the first capacitor and the first terminal of the second capacitor, the first output terminal of the rectifier is electrically connected to the first terminal of the first capacitor and the respective first terminals of the first and the fourth resistors, the second output terminal of the rectifier is grounded and electrically connected to the second terminal of the second capacitor.

13. A driver according to Claim 8, further comprising:

- a current-limiting circuit, including:

- a voltage divider electrically connected to the compensation capacitor set in parallel and having a first midpoint;

- an overtemperature protection circuit, including:

- a first transistor having a first terminal, a second terminal and a control terminal, wherein the first terminal of the first transistor is electrically connected to the LED; and

a second transistor having a first terminal, a second terminal and a control terminal, wherein the first terminal of the second transistor is electrically connected to the control terminal of the first transistor and the first midpoint; and

a current-limiting resistor having a first and a second terminals, wherein the first terminal of the current-limiting resistor is electrically connected to the second terminal of the first transistor and the control terminal of the second transistor, and the second terminal of the current-limiting resistor is grounded.

14. A driver according to Claim 13, further comprising an AC input power source, an inductor having a first and a second terminals, and a rectifier having a first and a second input terminals and a first and a second output terminals, wherein the LED includes an anode and a cathode, the overtemperature protection circuit further includes a first and a second resistors, each of which has a first and a second terminals, the first terminal of the first resistor is electrically connected to the first terminal of the current-limiting resistor, the second terminal of the first resistor is grounded, the first terminal of the second resistor is electrically connected to the second terminal of the second transistor, and the second terminal of the second resistor is grounded.

15. A driver according to Claim 14, wherein each of the first and the second capacitors has a first and a second terminals, the voltage divider further includes a third and a fourth resistors, each of which has a first and a second terminals, the compensation capacitor set further includes a fifth resistor having a first and a second terminals, the first terminal of the third resistor is electrically connected to the anode of the LED and the first terminal of the first capacitor, the cathode of the LED is electrically connected to the first terminal of the first transistor, the second terminal of the third resistor is electrically connected to the first terminal of the fourth resistor, the second terminal of the fourth resistor is grounded, the AC input power source is electrically connected to the first terminal of the inductor and the second input terminal of the rectifier, the second terminal of the inductor is electrically connected to the first input terminal of

the rectifier, the second input terminal of the rectifier is electrically connected to the first terminal of the fifth resistor, the second terminal of the fifth resistor is electrically connected to the second terminal of the first capacitor and the first terminal of the second capacitor, the first output terminal of the rectifier is electrically connected to the first terminal of the first capacitor, and the second output terminal of the rectifier is grounded and electrically connected to the second terminal of the second capacitor.