# CLAIMS

What is claimed is:

1. An LED array switching apparatus, comprising:

a plurality of LED arrays arranged in a serial path, each LED array having a forward voltage;

a voltage supply coupled to the plurality of LED arrays;

a plurality of current sources selectively coupled to the LED arrays, each of the current sources being switchable between a current regulating state and an open state; and

a controller that outputs at least one control signal generated based on at least one of: (a) at least one comparison between the voltage of the voltage supply and at least one reference voltage, and (b) currents through one or more of the current sources, the control signals controlling the turning on and off of at least one switch and a current source associated with the at least one switch,

the controller, the at least one switch and current sources cooperating together such that:

when the voltage of the voltage source is below the at least one reference voltage, and/or when a predetermined level of current passes through the one or more current sources, at least one switch is closed and one or more associated current sources are controlled so as to break the serial path into one or more parallel paths each including less than all of the LED arrays.

2. The LED array switching apparatus according to claim 1, wherein for at least a portion of time during which the voltage of the voltage supply is below at least one reference voltage, the one or more parallel paths comprise a plurality of parallel paths each including at least one of the LED arrays, the plurality of parallel paths supplying current to all of the LED arrays.

3. The LED array switching apparatus according to claim 1, further comprising:

at least one diode arranged in the serial path of the LED arrays intermediate between a first group of LED arrays and a second group of LED arrays; and

a switchable parallel current path that connects the voltage supply to a point in the serial path between the diode and the second group of LED arrays,

the at least one diode preventing current from the parallel current path from flowing in the direction of the first group of LED arrays.

4. The LED array switching apparatus according to claim 3, wherein the number of LED arrays in the first group of LED arrays is equal to the number of LED arrays in the second group of LED arrays.

5. The LED array switching apparatus according to claim 3, wherein a plurality of parallel paths supplies current to all of the LED arrays when the voltage of the voltage source is higher than the forward voltage of both of the first or second group of LED arrays, but is less than the at least one reference voltage.

6. The LED array switching apparatus according to claim 1, wherein the voltage source is a rectified AC voltage, the switching apparatus further comprising:

valley-fill circuitry configured to prevent occurrence of any off period of light output at a zero crossing portion of the AC voltage.

7. The LED array switching apparatus according to claim 6, wherein the valley-fill circuitry includes at least one energy storage capacitor that discharges when the rectified AC voltage drops below half its peak value to prevent any off period of the light output.

8. The LED array switching apparatus according to claim 1, wherein at least one of the plurality of LED arrays comprises a plurality of LEDs.

9. The LED array switching apparatus according to claim 8, wherein the plurality of LEDs forming the at least one of the plurality of LED arrays are arranged in parallel.

10. The LED array switching apparatus according to claim 1, wherein the controller comprises one or more voltage comparators.

11. The LED array switching apparatus according to claim 1, wherein the controller comprises a microcontroller.

12. The LED array switching apparatus according to claim 11, wherein the microcontroller is configured to detect a fault in an LED array and modify a switching sequence to exclude the faulted LED array.

13. The LED array switching apparatus according to claim 1, wherein the at least one reference voltage is a plurality of reference voltages, and the at least one switch is a plurality of switches, and each of the plurality of reference voltages corresponds with a respective one of the switches.

14. An LED array switching apparatus, comprising:

a plurality of LED arrays arranged in a serial path, each LED array having a forward voltage;

a voltage supply coupled to the plurality of LED arrays;

a voltage comparator that compares the voltage of the voltage supply with a reference voltage and controls a switch to turn off when the voltage of the voltage supply is greater than or equal to the reference voltage; and

a plurality of current sources selectively coupled to the LED arrays each of the current sources is switchable between a current regulating state and an open state,

the voltage comparator, the switch and current sources cooperating together such that:

(a) when the voltage of the voltage source is below the reference voltage, the switch is closed and the current sources are controlled so as to break the serial path into one or more parallel paths each including less than all of the LED arrays, and

(b) when the voltage of the voltage supply is greater than or equal to the reference voltage, as the voltage of the voltage supply increases, LED arrays are switched on and lit to form a higher forward voltage LED string, and as the voltage of the voltage supply decreases, LED arrays are switched off and removed from the LED string starting with the most recently lit array.

15. The LED array switching apparatus according to claim 14, wherein for at least a portion of time during which the voltage of the voltage supply is below the reference voltage, the one or more parallel paths comprise a plurality of parallel paths each including at least one of the LED arrays, the plurality of parallel paths supplying current to all of the LED arrays.

16. The LED array switching apparatus according to claim 14, further comprising:

a diode arranged in the series path of the LED arrays intermediate between a first group of LED arrays and a second group of LED arrays; and

a switchable parallel current path that connects the voltage supply to a point in the series path between the diode and the second group of LED arrays,

the diode preventing current from the parallel current path from flowing in the direction of the first group of LED arrays.

17. The LED array switching apparatus according to claim 16, wherein the number of LED arrays in the first group of LED arrays is equal to the number of LED arrays in the second group of LED arrays.

18. The LED array switching apparatus according to claim 16, wherein a plurality of parallel paths supplies current to all of the LED arrays when the voltage of the voltage source is higher than the forward voltage of both of the first or second group of LED arrays, but is less than the reference voltage.

19. The LED array switching apparatus according to claim 14, wherein the voltage source is a rectified AC voltage, the switching apparatus further comprising:

valley-fill circuitry configured to prevent occurrence of any off period of light output at a zero crossing portion of the AC voltage.

20. The LED array switching apparatus according to claim 19, wherein the valley-fill circuitry includes at least one energy storage capacitor that discharges when the rectified AC voltage drops below half its peak value to prevent any off period of the light output.

21. The LED array switching apparatus according to claim 16, wherein the sum of the forward voltages of LED arrays in the first group of LED arrays is approximately equal to sum of the forward voltages of the LED arrays in the second group of LED arrays.

22. The LED array switching apparatus according to claim 14, wherein at least one of the plurality of LED arrays comprises a plurality of LEDs.

23. The LED array switching apparatus according to claim 22, wherein the plurality of LEDs forming the at least one of the plurality of LED arrays are arranged in parallel.

## CLAIMS

What is claimed is:

1. An LED array switching apparatus, comprising:

a plurality of LED arrays arranged in a serial path, each LED array having a forward voltage;

a voltage supply coupled to the plurality of LED arrays;

a plurality of current sources selectively coupled to the LED arrays, each of the current sources being switchable between a current regulating state and an open state; and

a controller that outputs at least one control signal generated based on at least one of: (a) at least one comparison between the voltage of the voltage supply and at least one reference voltage, and (b) currents through one or more of the current sources, the control signals controlling the turning on and off of at least one switch and a current source associated with the at least one switch,

the controller, the at least one switch and current sources cooperating together such that:

when the voltage of the voltage source is below the at least one reference voltage, and/or when a predetermined level of current passes through the one or more current sources, at least one switch is closed and one or more associated current sources are controlled so as to break the serial path into one or more parallel paths each including less than all of the LED arrays, wherein the LED arrays in the one or more parallel paths are on,

wherein each current source comprises:

a first transistor having a gate, a drain, and a source, wherein the drain of the first transistor is coupled to its respective LED array;

a second transistor having a base, collector, and emitter, wherein the base is coupled to the source of the first transistor, the collector is coupled to the gate of the first transistor, and the emitter is coupled to ground; and

a zener diode coupled between the collector and emitter of the second transistor.

2. The LED array switching apparatus according to claim 1, wherein for at least a portion of time during which the voltage of the voltage supply is below at least one reference voltage, the one or more parallel paths comprise a plurality of parallel paths each including at least one of the LED arrays, the plurality of parallel paths supplying current to all of the LED arrays.

3. The LED array switching apparatus according to claim 1, further comprising:

at least one diode arranged in the serial path of the LED arrays intermediate between a first group of LED arrays and a second group of LED arrays; and

a switchable parallel current path that connects the voltage supply to a point in the serial path between the diode and the second group of LED arrays,

the at least one diode preventing current from the parallel current path from flowing in the direction of the first group of LED arrays.

4. The LED array switching apparatus according to claim 3, wherein the number of LED arrays in the first group of LED arrays is equal to the number of LED arrays in the second group of LED arrays.

5. The LED array switching apparatus according to claim 3, wherein a plurality of parallel paths supplies current to all of the LED arrays when the voltage of the voltage source is higher than the forward voltage of both of the first or second group of LED arrays, but is less than the at least one reference voltage.

6. The LED array switching apparatus according to claim 1, wherein the voltage source is a rectified AC voltage, the switching apparatus further comprising: valley-fill circuitry configured to prevent occurrence of any off period of light output at a zero crossing portion of the AC voltage.

7. The LED array switching apparatus according to claim 6, wherein the valley-fill circuitry includes at least one energy storage capacitor that discharges when the rectified AC voltage drops below half its peak value to prevent any off period of the light output.

8. The LED array switching apparatus according to claim 1, wherein at least one of the plurality of LED arrays comprises a plurality of LEDs.

9. The LED array switching apparatus according to claim 8, wherein the plurality of LEDs forming the at least one of the plurality of LED arrays are arranged in parallel.

10. The LED array switching apparatus according to claim 1, wherein the controller comprises one or more voltage comparators.

11. The LED array switching apparatus according to claim 1, wherein the controller comprises a microcontroller.

12. The LED array switching apparatus according to claim 11, wherein the microcontroller is configured to detect a fault in an LED array and modify a switching sequence to exclude the faulted LED array.

13. The LED array switching apparatus according to claim 1, wherein the at least one reference voltage is a plurality of reference voltages, and the at least one switch is a plurality of switches, and each of the plurality of reference voltages corresponds with a respective one of the switches.

14. An LED array switching apparatus, comprising:

a plurality of LED arrays arranged in a serial path, each LED array having a forward voltage;

a voltage supply coupled to the plurality of LED arrays;

a voltage comparator that compares the voltage of the voltage supply with a reference voltage and controls a switch to turn off when the voltage of the voltage supply is greater than or equal to the reference voltage; and

a plurality of current sources selectively coupled to the LED arrays each of the current sources is switchable between a current regulating state and an open state,

the voltage comparator, the switch and current sources cooperating together such that:

(a) when the voltage of the voltage source is below the reference voltage, the switch is closed and the current sources are controlled so as to break the serial path into one or more parallel paths each including less than all of the LED arrays, and

(b) when the voltage of the voltage supply is greater than or equal to the reference voltage, as the voltage of the voltage supply increases, LED arrays are switched on and lit to form a higher forward voltage LED string, and as the voltage of the voltage supply decreases, LED arrays are switched off and removed from the LED string starting with the most recently lit array,

wherein, wherein each current source comprises:

a first transistor having a gate, a drain, and a source, wherein the drain of the first transistor is coupled to its respective LED array;

a second transistor having a base, collector, and emitter, wherein the base is coupled to the source of the first transistor, the collector is coupled to the gate of the first transistor, and the emitter is coupled to ground; and

a zener diode coupled between the collector and emitter of the second transistor.

15. The LED array switching apparatus according to claim 14, wherein for at least a portion of time during which the voltage of the voltage supply is below the reference voltage, the one or more parallel paths comprise a plurality of parallel paths each including at least one of the LED arrays, the plurality of parallel paths supplying current to all of the LED arrays.

16. The LED array switching apparatus according to claim 14, further comprising:

a diode arranged in the series path of the LED arrays intermediate between a first group of LED arrays and a second group of LED arrays; and

a switchable parallel current path that connects the voltage supply to a point in the series path between the diode and the second group of LED arrays,

the diode preventing current from the parallel current path from flowing in the direction of the first group of LED arrays.

17. The LED array switching apparatus according to claim 16, wherein the number of LED arrays in the first group of LED arrays is equal to the number of LED arrays in the second group of LED arrays.

18. The LED array switching apparatus according to claim 16, wherein a plurality of parallel paths supplies current to all of the LED arrays when the voltage of the voltage source is higher than the forward voltage of both of the first or second group of LED arrays, but is less than the reference voltage.

19. The LED array switching apparatus according to claim 14, wherein the voltage source is a rectified AC voltage, the switching apparatus further comprising:

valley-fill circuitry configured to prevent occurrence of any off period of light output at a zero crossing portion of the AC voltage.

20. The LED array switching apparatus according to claim 19, wherein the valley-fill circuitry includes at least one energy storage capacitor that discharges when the rectified AC voltage drops below half its peak value to prevent any off period of the light output.

21. The LED array switching apparatus according to claim 16, wherein the sum of the forward voltages of LED arrays in the first group of LED arrays is approximately equal to sum of the forward voltages of the LED arrays in the second group of LED arrays.

22. The LED array switching apparatus according to claim 14, wherein at least one of the plurality of LED arrays comprises a plurality of LEDs.

23. The LED array switching apparatus according to claim 22, wherein the plurality of LEDs forming the at least one of the plurality of LED arrays are arranged in parallel.