CLAIMS

What is claimed is:

1. A voltage regulator, comprising:

a reconfigurable inductor;

the reconfigurable inductor having a conductive control ring, the conductive control ring having an adjustable enclosed area controlled by at least a first switch; and

a controller electrically coupled to the conductive control ring,

wherein the reconfigurable inductor has a varying inductance based on a state of at least the first switch and the adjustable enclosed area of the conductive control ring, wherein the reconfigurable inductor is configured to generate magnetic field lines when current flows through the inductor, and wherein the adjustable enclosed area is configured to generate opposing field lines to intersect with the magnetic field lines when a current flows through the conductive control ring and at least the first switch is in the on state, and wherein the controller is configured to increase the adjustable enclosed area to cause the opposing field lines to increase a total opposing magnetic flux, and wherein the varying inductance of the reconfigurable inductor is decreased when the opposing field lines are increased.

2. The voltage regulator of claim 1, wherein the reconfigurable inductor is coupled between a power supply and a load, and receives electrical power from the power supply and provides electrical power to the load.

3. The voltage regulator of claim 2, wherein the state of the first switch comprises an on state when the first switch is closed and an off state when the first switch is open.

4. The voltage regulator of claim 3, wherein the controller is configured to control the state of the first switch to vary inductance of the reconfigurable inductor based on a size of the adjustable enclosed area when at least the first switch is in the on state.

5. The voltage regulator of claim 3, wherein the conductive control ring comprises a plurality of switches which include the first switch, and wherein the reconfigurable inductor has a maximum inductance when each switch of the conductive control ring is in the off state, and is configured to create more than one inductance values based on the plurality of switches that are in the on state.

6. The voltage regulator of claim 5, wherein the adjustable enclosed area of the conductive control ring is controlled based on the plurality of switches that are in the on state.

7. The voltage regulator of claim 1, wherein the varying inductance of the reconfigurable inductor is configured to vary inductance of the inductor over a range of inductance values, and wherein the reconfigurable inductor further comprises a plurality of conductive control rings.

8. A method to reduce undershoot in a switching voltage regulator using a reconfigurable inductor during a load transient moment, the method comprising:

determining whether the switching voltage regulator is operating in a voltage sensing voltage regulator (VR) mode or a current sensing VR mode, wherein the switching voltage regulator comprises:

the reconfigurable inductor;

the reconfigurable inductor having a conductive control ring, the conductive control ring having an adjustable enclosed area controlled by at least a first switch; and

a controller electrically coupled to the conductive control ring,

wherein the reconfigurable inductor has a varying inductance based on a state of at least the first switch and the adjustable enclosed area of the conductive control ring, wherein the reconfigurable inductor is configured to generate magnetic field lines when current flows through the inductor, and wherein the adjustable enclosed area is configured to generate opposing field lines to intersect with the magnetic field lines when a current flows through the conductive control ring and at least the first switch is in the on state, and wherein the controller is configured to increase the adjustable enclosed area to cause the opposing field lines to increase a total opposing magnetic flux, and wherein the varying inductance of the reconfigurable inductor is decreased when the opposing field lines are increased;

determining whether a first reference voltage is greater than a second reference voltage when the switching voltage regulator is operating in the voltage sensing VR mode, wherein the step of determining in the voltage sensing VR mode further comprises:

maintaining the first switch in the reconfigurable inductor in an off state when the first reference voltage is not greater than the second reference voltage, and

maintaining the first switch in the reconfigurable inductor in an on state when the first reference voltage is greater than the second reference voltage; and

determining whether a third reference voltage is greater than a fourth reference voltage when the switching voltage regulator is operating in the current sensing VR mode, wherein the step of determining in the current sensing VR mode further comprises:

maintaining the first switch in the reconfigurable inductor in the off state when the third reference voltage is not greater than the fourth reference voltage, and

maintaining the first switch in the reconfigurable inductor in the on state when the third reference voltage is greater than the fourth reference voltage.

9. The method of claim 8, wherein the second reference voltage is derived from an output voltage and an under voltage protection threshold.

10. The method of claim 8, wherein the third reference voltage is derived from a voltage identification output, a load line value, and an under voltage protection offset.

11. The method of claim 8, further comprising:

detecting the load transient moment with a first comparator when the switching voltage regulator is operating in the voltage sensing VR mode, the comparator having a first input terminal, a second input terminal, and an output terminal, the first input terminal coupled to the first reference voltage, the second input terminal coupled to the second reference voltage, and the output terminal coupled to the first switch in the reconfigurable inductor, wherein the output terminal is configured to generate a first control bit to trigger the first switch to the on state in response to the load transient moment and is configured to generate a second control bit to trigger the first switch to the off state to re-assert a steady state.

12. The method of claim 8, further comprising:

detecting a load transient moment with a second comparator when the switching voltage regulator is operating in the current sensing VR mode, the second comparator having a first input terminal, a second input terminal, and an output terminal, the first input terminal coupled to the third reference voltage, the second input terminal coupled to the fourth reference voltage, and the output terminal coupled to the first switch in the reconfigurable inductor, wherein the output terminal is configured to generate a first control bit to trigger the first switch to the on state in response to the load transient moment and is configured to generate a second control bit to trigger the first switch to the off state to re-assert a steady state.

13. The method of claim 11, wherein the steady state of the reconfigurable inductor is proportional to the off state and is configured to provide a maximum inductance.

14. The method of claim 8, wherein the on state of the reconfigurable inductor is configured to provide a reduced inductance value in response to the load transient moment.

15. The method of claim 8, wherein prior to determining whether the third reference voltage is greater than the fourth reference voltage in the current sensing VR mode further comprises:

determining a sensed voltage at a load point, wherein the sensed voltage is coupled to the fourth reference voltage; and

determining a sensed inductor current in a power stage.

16. A method to reduce overshoot in a switching voltage regulator using a reconfigurable inductor during a load transient moment, the method comprising:

determining whether the switching voltage regulator is operating in a voltage sensing voltage regulator (VR) mode or a current sensing VR mode, wherein the switching voltage regulator comprises:

the reconfigurable inductor;

the reconfigurable inductor having a conductive control ring, the conductive control ring having an adjustable enclosed area controlled by at least a first switch; and

a controller electrically coupled to the conductive control ring,

wherein the reconfigurable inductor has a varying inductance based on a state of at least the first switch and the adjustable enclosed area of the conductive control ring, wherein the reconfigurable inductor is configured to generate magnetic field lines when current flows through the inductor, and wherein the adjustable enclosed area is configured to generate opposing field lines to intersect with the magnetic field lines when a current flows through the conductive control ring and at least the first switch is in the on state, and wherein the controller is configured to increase the adjustable enclosed area to cause the opposing field lines to increase a total opposing magnetic flux, and wherein the varying inductance of the reconfigurable inductor is decreased when the opposing field lines are increased;

determining whether a first reference voltage is greater than a second reference voltage when the switching voltage regulator is operating in the voltage sensing VR mode, wherein the step of determining in the voltage sensing VR mode further comprises:

maintaining a first switch in the reconfigurable inductor in an off state when the first reference voltage is not greater than the second reference voltage, and

maintaining the first switch in the reconfigurable inductor in an on state when the first reference voltage is greater than the second reference voltage; and

determining whether a third reference voltage is greater than a fourth reference voltage when the switching voltage regulator is operating in the current sensing VR mode, wherein the step of determining in the current sensing VR mode further comprises:

maintaining the first switch in the reconfigurable inductor in the off state when the third reference voltage is not greater than the fourth reference voltage, and

maintaining the first switch in the reconfigurable inductor in the on state when the third reference voltage is greater than the fourth reference voltage.

17. The method of claim 16, wherein the second reference voltage is derived from a reference voltage and an over voltage protection threshold.

18. The method of claim 16, wherein the fourth reference voltage is derived from a voltage identification output and an over voltage protection threshold.

19. The method of claim 16, further comprising:

detecting the load transient moment with a first comparator when the switching voltage regulator is operating in the voltage sensing VR mode, the comparator having a first input terminal, a second input terminal, and an output terminal, the first input terminal coupled to the first reference voltage, the second input terminal coupled to the second reference voltage, and the output terminal coupled to the first switch in the reconfigurable inductor, wherein the output terminal is configured to generate a first control bit to trigger the first switch to the on state in response to the load transient moment and is configured to generate a second control bit to trigger the first switch to the off state to re-assert a steady state.

20. The method of claim 16, further comprising:

detecting a load transient moment with a second comparator when the switching voltage regulator is operating in the current sensing VR mode, the second comparator having a first input terminal, a second input terminal, and an output terminal, the first input terminal coupled to the third reference voltage, the second input terminal coupled to the fourth reference voltage, and the output terminal coupled to the first switch in the reconfigurable inductor, wherein the output

terminal is configured to generate a first control bit to trigger the first switch to the on state in response to the load transient moment and is configured to generate a second control bit to trigger the first switch to the off state to re-assert a steady state.

21. The method of claim 19, wherein the steady state of the reconfigurable inductor is proportional to the off state and is configured to provide a maximum inductance.

22. The method of claim 16, wherein the on state of the reconfigurable inductor is configured to provide a reduced inductance value in response to the load transient moment.

23. The method of claim 16, wherein prior to determining whether the third reference voltage is greater than the fourth reference voltage in the current sensing VR mode further comprises:

determining a sensed voltage at a load point, wherein the sensed voltage is coupled to the fourth reference voltage.