[0034] Figures 10-12 are schematic illustrations of the switch capacitor voltage breakdown circuit shown in Figure 8 in a charge phase mode and a discharge phase mode associated with each of the gain settings shown in Figure 9, according to an embodiment of the present invention;

[0035] Figure 13 is a schematic diagram of a forward converter circuit that may be used with the power circuit shown in Figure 2, according to an embodiment of the present invention;

[0036] Figure 14 is a schematic diagram of an alarm control circuit that may be used with the power circuit shown in Figure 2, according to an embodiment of the present invention;

[0037] Figure 15A and 15B ~~is another~~ are schematic diagrams of the power circuit shown in Figure 2, including a power controller integrated circuit, according to an embodiment of the present invention;

[0038] Figures 16, 17A, and 17B are block diagrams of the power controller integrated circuit shown in Figure 10, according to embodiments of the present invention;

[0039] Figure 18 is a block diagram of a power management unit that may be used with the power controller integrated circuit shown in Figures 16, 17A, and 17B, according to an embodiment of the present invention;

[0040] Figure 19 is a graphic illustration of Power-On-Reset threshold voltages that may be used with the power controller integrated circuit shown in Figures 16, 17A, and 17B;

[0041] Figure 20 is a schematic illustration of a Proportional to Integral and Differential Regulator Control circuit that may be used with the power controller integrated circuit shown in Figures 16, 17A, and 17B, according to an embodiment of the present invention;

[0042] Figures 21 and 22 are block diagrams of a digital control block that may be used with the power controller integrated circuit shown in Figures 16, 17A, and 17B, according to embodiments of the present invention;

the sense resistor circuit segment 109. Further, if an AC circuit does not need to be rectified or isolated, than this circuit can work with AC as well as DC.

[0098] Figure 15A and 15B ~~is~~are schematic diagrams of the power module 12 including a power controller integrated circuit (Tronium PSSoC) 106 that may be used with the electrical power circuit 22. Figures 16, 17A, and 17B are block diagrams of the Tronium PSSoC 106. In the illustrated embodiment, the power module 12 includes a printed circuit board 108 and the Tronium PSSoC 106 that is formed within a packaged chip and is coupled to the printed circuit board 108. At least a portion of the electrical circuit 22 is included within the Tronium PSSoC 106. In addition, the digital control may be conducted by either a microprocessor, external or embedded on the chip or a state machine. In one embodiment, some or all of the electrical circuits and electrical components included in the electrical circuit 22 are included within the Tronium PSSoC 106. The Tronium PSSoC 106 may be configured for use in two primary power module applications including an Autonomous Power Module (shown in Figures 16 and 28) and a Universal Power Module (shown in Figures 17A, 17B, and 29). For example, as shown in Figure 16, the Autonomous Power Module includes a Tronium PSSoC 106 that is configured to operate in an autonomous mode of operation that is based upon an analog feedback approach for reduced cost. The Universal Power Module, shown in Figures 17A and 17B, includes a Tronium PSSoC 106 that is configured to operate in a universal mode of operation and that utilizes a microprocessor (μP) controller to provide feedback for regulation of the final output voltage.

[0099] In the illustrated embodiment, the Tronium PSSoC 106 is configured to meet predefined requirements for traceability, marking, solderability, and/or solvent resistance. The Tronium PSSoC 106 is marked to indicate a date code, plant identifier, and traceability/authenticity code. The authenticity code provides a means of identification and

CLAIMS

What is claimed is:

1. An electrical circuit for providing electrical power for use in powering electronic devices, comprising:

a primary power circuit adapted to be electrically coupled to an electrical power source, the primary power circuit configured to receive an alternating current (AC) input power signal from the electrical power source and generate an intermediate direct current (DC) power signal, the intermediate DC power signal being generated at a first voltage level that is less than a voltage level of the AC input power signal, the primary power circuit including:

a rectifier circuit configured to receive the AC power input signal from the electrical power source and generate a rectified DC power signal, the rectified DC power signal having a voltage level that is approximately equal to the voltage level of the AC input power signal; and

a switch capacitor voltage breakdown circuit coupled to the rectifier circuit for receiving the rectified DC power signal from the rectifier circuit and generating the intermediate DC power signal, the switch capacitor voltage breakdown circuit including:

a pair of flyback capacitors electrically coupled in parallel;

a plurality of switch assemblies electrically coupled to each of the pair of flyback capacitors, the plurality of switch assemblies being operated between a charge phase and a discharge phase; and

a hold capacitor electrically coupled to each of the flyback capacitors, the plurality of switch assemblies being operated to selectively deliver the rectified DC power signal to each

of the flyback capacitors during the charge phase and to selectively deliver the intermediate DC power signal to the hold capacitor during the discharge phase; and

a secondary power circuit electrically coupled to the primary power circuit, the secondary power circuit configured to receive the intermediate DC power signal from the primary power circuit and deliver an output DC power signal to an electronic device, the output DC power signal being delivered at an output voltage level that is less than the first voltage level of the intermediate DC power signal.

2. An electrical circuit in accordance with claim 1, ~~the primary power circuit including a rectifier circuit configured to receive the AC power input signal from the electrical power source and generate a rectified DC power signal, the rectified DC power signal having a voltage level that is approximately equal to the voltage level of the AC input power signal~~further comprising an integrated circuit controller including a processor programmed to sense the input voltage level and transmit control signals to the switch capacitor voltage breakdown circuit for regulating the switch assemblies as a function of the sensed input voltage level.

3. An electrical circuit in accordance with claim 12, ~~the rectifier circuit including a full-wave bridge rectifier~~processor programmed to regulate the switch capacitor voltage breakdown circuit to facilitate capacitive isolation.

4. An electrical circuit in accordance with claim 2, ~~the primary power circuit including a switch capacitor voltage breakdown circuit coupled to the rectifier circuit for receiving the rectified DC power signal from the rectifier circuit and generating the intermediate DC power signal~~ including a vampire load elimination subsystem including a current sensor for sensing a current level of the output DC power signal, the processor

programmed to shut-off input power to the primary power circuit if the sensed current level is different from a predefined current level.

5. An electrical circuit in accordance with claim 24, ~~the switch capacitor voltage breakdown circuit including:~~

~~a pair of flyback capacitors electrically coupled in parallel;~~

~~a plurality of switch assemblies electrically coupled to each of the pair of flyback capacitors, the plurality of switch assemblies being operated between a charge phase and a discharge phase; and~~

~~a hold capacitor electrically coupled to each of the pair of flyback capacitors, the plurality of switch assemblies being operated to selectively deliver the rectified DC power signal to each of the pair of flyback capacitors during the charge phase and to selectively deliver the intermediate DC power signal to the hold capacitor during the discharge phase~~ including a communications controller coupled to the processor for transmitting control signals to the processor to enable remote operation of the electrical circuit.

6. An electrical circuit in accordance with claim 15, at least one of the switch assemblies including:

a ~~N-channel~~ MOSFET switch;

at least one level shifter coupled to the ~~N-channel~~ MOSFET switch for receiving an LDO signal and delivering a control signal to the ~~N-channel~~ MOSFET switch as a function of the LDO signal; and

a dickson charge pump coupled to the level shifter, the dickson charge pump configured to receive the rectified DC power signal and generate an output power signal having a voltage level that is greater than the voltage level of the rectified DC power signal,

the output power signal being delivered to the level shifter for use in operating ~~N-channel~~ MOSFET switch.

7. An electrical circuit in accordance with claim 5, the switch capacitor voltage breakdown circuit including a switch capacitor control circuit coupled to each of the plurality of switch assemblies, the switch capacitor control circuit including:

a voltage sensing circuit for sensing a voltage level of the rectified DC power signal; and

a gain controller configured to select a gain setting of the switch capacitor voltage breakdown circuit as a function of the sensed voltage level and operating each of the plurality of switch assemblies as a function of the selected gain setting.

8. An electrical circuit in accordance with claim 14, the primary power circuit including a buck regulator circuit ~~electrically coupled in parallel with the switch capacitor voltage breakdown circuit, the buck regulator circuit~~ for receiving the rectified DC power signal from the rectifier circuit and generating ~~the~~a second intermediate DC power signal.

9. An electrical circuit in accordance with claim 8, the buck regulator circuit including a regulator switch assembly coupled to a voltage reduction circuit, the voltage reduction circuit including at least one diode, an inductor, and a capacitor, the regulator switch assembly being operated to selectively deliver the rectified DC power signal to the voltage reduction circuit.

10. An electrical circuit in accordance with claim 9, the buck regulator circuit including a buck regulator control circuit for providing a pulse-width modulated control signal to the regulator~~ed~~ switch assembly to selectively deliver the rectified DC power signal to the voltage reduction circuit, the buck regulator control circuit including:

a voltage sensing circuit for sensing the first voltage level of the intermediate DC power signal; and

a regulator controller for generating the pulse-width modulated control signal as a function of the sensed first voltage level, the regulator controller configured to adjust a duty cycle of the control signal being delivered to maintain the voltage level of the intermediate DC power signal at a predefined voltage level.

11. An electrical circuit in accordance with claim 1, the secondary power circuit including a forward converter circuit including a primary voltage reduction circuit and a secondary voltage reduction circuit, the primary voltage reduction circuit configured to receive the intermediate DC power signal from the primary power circuit and deliver a secondary DC power signal to the secondary voltage reduction circuit, the secondary DC power signal having a voltage level that is less than the voltage level of the intermediate DC power signal, the secondary voltage reduction circuit configured to receive the secondary DC power signal and generate the output DC power signal being delivered to the electronic device.

12. An electrical circuit in accordance with claim 11, the primary voltage reduction circuit including a transformer, a primary side of the transformer being coupled to the primary power circuit and a secondary side of the transformer being coupled to the secondary voltage reduction circuit.

13. An electrical circuit in accordance with claim 12, ~~the secondary voltage reduction circuit including a pair of diodes, an inductor, and a capacitor~~ including a primary side current sense circuit that is connected to the primary side of the transformer to sense the load current and the load voltage to facilitate regulating the DC output signal.

14. A power module for providing electrical power for use in powering electronic devices, comprising:

~~a rectifier circuit configured to receive an AC power input signal from an electrical power source and generate a rectified DC power signal;~~

at least one switch capacitor voltage breakdown circuit ~~and integrated circuit controller coupled to the rectifier circuit for receiving the rectified DC power signal from the rectifier circuit, the integrated circuit controller for sensing the voltage level of the AC power input signal and adjusting the gain of the switch capacitor voltage breakdown circuit as a function of the sensed voltage level to generate an intermediate DC power signal; and~~

~~a forward converter circuit coupled to the switch capacitor voltage breakdown circuit, the forward converter circuit including a transformer for receiving the intermediate DC power signal and generating an output DC power signal being delivered to an electronic device~~ for receiving a power input signal from an electrical power source and generate an output power signal, the at least one switch capacitor voltage breakdown circuit including:

a pair of flyback capacitors electrically coupled in parallel; and

a plurality of switch assemblies electrically coupled to each of the pair of flyback capacitors.

15. A power module in accordance with claim 14, including a buck regulator circuit electrically coupled in parallel with the switch capacitor voltage breakdown circuit~~, the buck regulator circuit including a regulator switch assembly for receiving the rectified DC power signal from the rectifier circuit and generating the intermediate DC power signal~~.

16. A power module in accordance with claim 15, ~~the~~including an integrated circuit controller ~~including a buck regulator control circuit for providing a pulse-width modulated~~

~~control signal to the regulated switch assembly~~ programmed to regulate the switch capacitor voltage breakdown circuit and the buck regulator circuit.

17. A power module in accordance with claim 14, including a forward converter circuit coupled to the switch capacitor voltage breakdown circuit, the forward converter circuit including a transformer ~~switch assembly~~ coupled to the ~~transformer primary side, the integrated circuit including a transformer control circuit for selectively operating the transformer switch assembly to maintain a voltage level of the output DC power signal~~ switch capacitor voltage breakdown circuit for receiving an intermediate power signal and delivering the output power signal to an electronic device.

18. A power module in accordance with claim 14, ~~the switch capacitor voltage breakdown circuit including:~~

~~a pair of flyback capacitors electrically coupled in parallel; and~~

~~a plurality of switch assemblies electrically coupled to each of the pair of flyback capacitors~~ including a semiconductor chip, the flyback capacitors and the switch assemblies being formed on the semiconductor chip.

19. A power module in accordance with claim 14~~18~~, at least one of the switch assemblies including:

a ~~N-channel~~ MOSFET switch; and

a dickson charge pump coupled to the ~~N-channel~~ MOSFET switch.

20. A power module in accordance with claim 19~~8~~, wherein the ~~N-channel~~ MOSFET ~~is~~ switch includes a high voltage MOSFET formed ~~within the~~ on a low voltage integrated circuit.