CLAIMS

What is claimed is:

1. A power supply system, comprising:

a plurality of power blocks, each power block adapted to convey power to a respective load responsive to a respective pulse width modulation (PWM) control signal; and

a digital power manager adapted to (1) program operating parameters and receive monitoring data of said plurality of power blocks using peripherals integrated in said digital power manager, and (2) generate the PWM control signals of all the power blocks in response to said monitoring data so as to implement closed-loop control of the power conveyed by each of said plurality of power blocks.

2. The power supply system of claim 1, wherein said power blocks include a power part of non-isolated DC/DC converters, signal sampling and conversion circuits, and driving circuits.

3. The power supply system of claim 1, wherein said digital power manager comprises an analog-to-digital converter (ADC), a digital pulse width modulator (DPWM), general purpose input/output interfaces, and a central processing unit (CPU).

4. The power supply system of claim 1, wherein said power blocks do not have protection functions.

5. The power supply system of claim 4, wherein said digital power manager implements protection functions for each of said plurality power blocks.

6. The power supply system of claim 1, wherein said power blocks are selected from point-of-load (POL) regulators, voltage regulator modules (VRM), power-on-load regulators, and DC/DC converters.

7. The power supply system of claim 1, wherein said operating parameters include output

voltage set point, sequencing, fault propagation configuration, and margining, and said monitoring data includes input voltage, output voltage, output current, and temperature.

8. The power supply system of claim 1, wherein said digital power manager further comprises a user interface adapted to receive programming data and send said monitoring data.

9. The power supply system of claim 8, wherein said user interface further comprises an I2C interface.

10. The power supply system of claim 1, further comprising a host user system coupled to said digital power manager, said the host user system further comprises a graphical user interface providing programming of said operating parameters and monitoring said monitoring data of each of said plurality of power blocks.

11. The power supply system of claim 1, wherein said digital power manager further comprises a non-volatile memory containing a plurality of registers.

12. The power supply system of claim 11, wherein said plurality of registers include:

an application register containing data values (1) programming operation of said power blocks and (2) monitoring state of said power blocks;

a configuration register containing data values defining a configuration of said power supply system;

a boot register containing data values reflecting base layer operation to said non-volatile memory;

buffers including an application buffer, a configuration buffer, and a boot buffer containing new firmware data;

a user-definable space; and

a logging data space containing field information in the event of failure.

13. The power supply system of claim 1, wherein said digital power manager is adapted to perform a respective closed-loop voltage control process for each of the power blocks, each

closed-loop voltage control process including:

calculating an error value as the difference between a reference value and a sense voltage representing an output voltage of the respective power block;

processing the error value to generate a processed error value; and

generating the PWM control signal for the respective power block based on the processed error value.

14. The power supply system of claim 13, wherein processing the error value includes executing an algorithm selected from a proportional-integral-derivative (PID) algorithm, a non-linear algorithm, a hysteretic algorithm, and an asynchronous algorithm.

15. The power supply system of claim 13, wherein said processing also includes processing of a sensed average/peak output current of each of the power blocks to realize closed-loop current control and/or closed-loop power control.

16. The power supply system of claim 1, further including a converter circuit operative to supply an intermediate bus voltage to each of the power blocks, and wherein said digital power manager is operative in response to said monitoring data of the power blocks and information representing power supplied by the converter circuit to control the intermediate bus voltage from the converter circuit to achieve a desired conversion efficiency of the power supply system.

17. A power supply system, comprising:

a plurality of power blocks, each power block adapted to draw power from an intermediate power bus and to convey power to a respective load;

a converter circuit operative in response to a voltage control signal to supply the power to the intermediate power bus at an intermediate bus voltage corresponding to the voltage control signal; and

a digital power manager adapted to (1) program operating parameters and receive monitoring data of said plurality of power blocks using peripherals integrated in said digital power manager, and (2) generate the voltage control signal in response to said monitoring data of the power blocks and information representing power supplied by the converter

circuit so as to control the intermediate bus voltage to achieve a desired conversion efficiency of the power supply system.

18. The power supply system of claim 17, wherein the digital power manager generates a discrete analog control signal supplied to the converter circuit to control the intermediate bus voltage generated by the converter circuit, the discrete analog control signal having an analog value representing a desired output voltage of the converter circuit and being used by the converter circuit to adjust its output voltage to the desired output voltage.

19. The power supply system of claim 17, wherein a digital communications bus connects the digital power manager to the converter circuit and is used by the digital power manager to control the intermediate bus voltage generated by the converter circuit.

CLAIMS

1. A power supply system, comprising:

a plurality of power blocks, each power block adapted to convey power to a respective load responsive to a respective pulse width modulation (PWM) control signal; and

a digital power manager adapted to (1) program operating parameters and receive monitoring data of said plurality of power blocks using input/output circuitry integrated in said digital power manager, and (2) generate the PWM control signals of all the power blocks in response to said monitoring data so as to implement closed-loop control of the power conveyed by each of said plurality of power blocks,

wherein said digital power manager further comprises a non-volatile memory containing a plurality of registers, said plurality of registers including:

an application register containing data values (1) programming operation of said power blocks and (2) monitoring state of said power blocks;

a configuration register containing data values defining a configuration of said power supply system;

a boot register containing data values reflecting base layer operation to said non-volatile memory;

buffers including an application buffer, a configuration buffer, and a boot buffer containing new firmware data;

a user-definable space; and

a logging data space containing field information in the event of failure.

2. The power supply system of claim 1, wherein said power blocks include a power part of non-isolated DC/DC converters, signal sampling and conversion circuits, and driving circuits.

3. The power supply system of claim 1, wherein said digital power manager comprises an analog-to-digital converter (ADC), a digital pulse width modulator (DPWM), general purpose input/output interfaces, and a central processing unit (CPU).

4. The power supply system of claim 1, wherein said operating parameters include output voltage set point, sequencing, fault propagation configuration, and margining, and said monitoring data includes input voltage, output voltage, output current, and temperature.

5. The power supply system of claim 1, wherein said digital power manager further comprises a user interface adapted to receive programming data and send said monitoring data.

6. The power supply system of claim 5, wherein said user interface further comprises an I2C interface.

7. The power supply system of claim 1, further comprising a host user system coupled to said digital power manager, said the host user system further comprises a graphical user interface providing programming of said operating parameters and monitoring said monitoring data of each of said plurality of power blocks.

8. The power supply system of claim 1, wherein said digital power manager is adapted to perform a respective closed-loop voltage control process for each of the power blocks, each closed-loop voltage control process including:

calculating an error value as the difference between a reference value and a sense voltage representing an output voltage of the respective power block;

processing the error value to generate a processed error value; and

generating the PWM control signal for the respective power block based on the processed error value.

9. The power supply system of claim 8, wherein processing the error value includes executing an algorithm selected from a proportional-integral-derivative (PID) algorithm, a non-linear algorithm, a hysteretic algorithm, and an asynchronous algorithm.

10. The power supply system of claim 8, wherein said processing also includes processing of a sensed average/peak output current of each of the power blocks to realize closed-loop current control and/or closed-loop power control.

11. The power supply system of claim 1, further including a converter circuit operative to supply an intermediate bus voltage to each of the power blocks, and wherein said digital power manager is operative in response to said monitoring data of the power blocks and information representing power supplied by the converter circuit to control the intermediate bus voltage from the converter circuit to achieve a desired conversion efficiency of the power supply system.

12. A power supply system, comprising:

a plurality of power blocks, each power block adapted to draw power from an intermediate power bus and to convey power to a respective load;

a converter circuit operative in response to a voltage control signal to supply the power to the intermediate power bus at an intermediate bus voltage corresponding to the voltage control signal; and

a digital power manager adapted to (1) program operating parameters and receive monitoring data of said plurality of power blocks using input/output circuitry integrated in said digital power manager, and (2) generate the voltage control signal in response to said monitoring data of the power blocks and information representing power supplied by the converter circuit so as to control the intermediate bus voltage to achieve a desired conversion efficiency of the power supply system.

13. The power supply system of claim 12, wherein the digital power manager generates a discrete analog control signal supplied to the converter circuit to control the intermediate bus voltage generated by the converter circuit, the discrete analog control signal having an analog value representing a desired output voltage of the converter circuit and being used by the converter circuit to adjust its output voltage to the desired output voltage.

14. The power supply system of claim 12, wherein a digital communications bus connects the digital power manager to the converter circuit and is used by the digital power manager to control the intermediate bus voltage generated by the converter circuit.

15. The power supply system of claim 12, wherein the digital power manager is configured and operative to execute an efficiency optimization routine that achieves a desired ratio of total delivered output power from the power blocks to the power provided by the converter circuit.

16. The power supply system of claim 12, wherein the digital power manager receives a signal representing a voltage at a source input and is configured and operative to execute an

efficiency optimization routine that achieves a desired ratio of total delivered output power from the power blocks to input power provided to the power supply system.

17. The power supply system of claim 16, wherein the efficiency optimization routine includes an input feed forward technique based on an approximation of output voltage as a function of applied input voltage and either switching duty cycle or switching frequency, the input feed forward technique including adjusting either switching duty cycle or switching frequency in relation to the applied input voltage to modify the intermediate bus voltage to achieve the desired ratio of total delivered output power from the power blocks to input power provided to the power supply system.

18. The power supply system of claim 12, wherein each power block has multiple connections to the digital power manager for signals including output current, output voltage, and operating temperature of the power block, and wherein the digital power manager is configured and operative to use the signals to calculate output power delivered from each of the power blocks and to sum the respective output powers of the power blocks to determine the total delivered output power.

19. The power supply system of claim 12 including connections and respective signals between the converter circuit and digital power manager for monitoring and control of the converter circuit by the digital power manager, the signals including a trim control signal controlling the intermediate bus voltage in proportion to a voltage of the trim control signal, the signals further including a current signal providing a measure of current delivered by the converter circuit to the intermediate bus.

20. The power supply system of claim 1, including a serial digital communications link between the digital power manager and the converter circuit, and wherein monitoring and

control signals are conveyed as corresponding digital values carried on the serial digital communications link.