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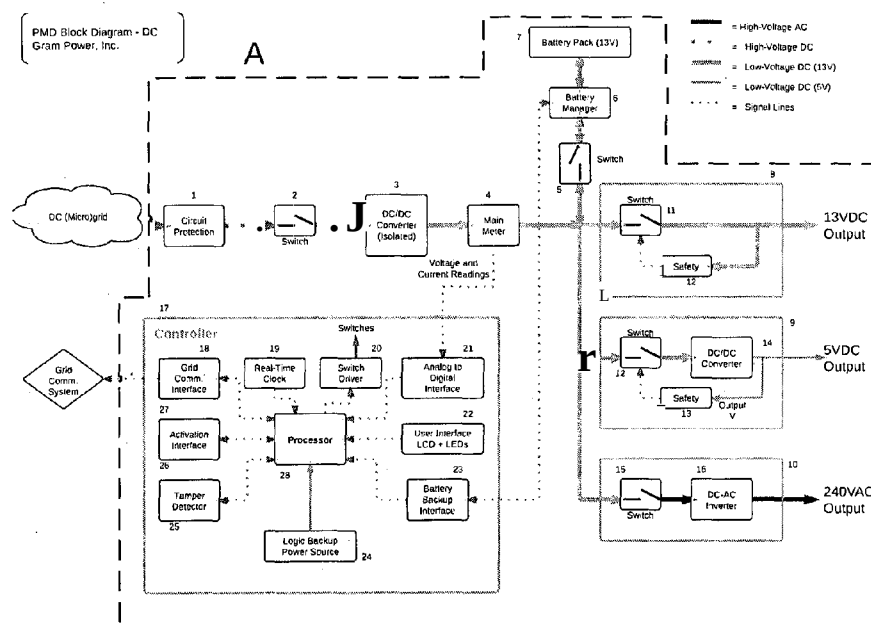
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(54) Title: POWER MANAGEMENT DEVICE AND SYSTEM



(57) Abstract: An intelligent user-side power management device (PMD) that is comprised of an optional energy storage unit and can interface with a utility grid or microgrid to eliminate power theft and efficiently provide clean energy to the users of the grid while helping the grid to do smart demand response management, particularly for renewable energy based grids that need to efficiently manage the slack due to the large variability in power generation through these energy sources.

AMENDED CLAIMS

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1. A smart power grid system for a cluster of power management devices (PMD) used for efficient monitoring, controlling, metering including equitable distribution of electrical power to the consumers corresponding to demand-generation status by eliminating power theft, the smart power grid comprising one or more of non-conventional variable energy generation sources, a traditional A.C. grid power, and/or a combination of conventional power grid including the non-conventional power generation source; a central controller, and a plurality of power management devices (PMD), wherein each of the PMD comprises:

a. a microcontroller with a processor, a plurality of interfaces, a switch driver, a tamper detector, and a logic for backup power source;

b. a circuit protection means;

c. a metering device to measure different types of power for example AC,DC, or a combination of A.C. and D.C.(hybrid) supplied by the smart grid and consumed by the consumers;

d. a plurality of switches for preventing overloading of the system, illegal consumption of power, and monitor supply from the grid, each operable by the switch driver;

e. a local storage means having a charge monitoring circuit for temporarily supplementing shortfall of generation or power consumption lower than generation; and

f. a grid communication interface allowing the PMDs to communicate with the central controller being physically connected or remotely implement an intelligent demand-response, identification of the area of power loss or theft, remote trouble shooting, and updating the payment for power consumption, the central controller in wireless or wired communications mode with the microcontrollers are enabled to maximize the power output from the generators, prioritize each PMD through associated fanout, distributed storage including equitable distribution of power, remote stack management prevent power-theft.

2. The smart power micro grid as claimed in claim 1, wherein the central controller is connected to a remote wireless transceiver.

3. The smart power microgrid as claimed in claim 1, comprising a central storage including a charge controller.

4. The smart power microgrid as claimed in claim 1, wherein when the microgrid is a AC grid interfaced to a power management device (B), the PMD (B) at user end is provided with a battery charger (33), a DC-AC inverter (16), and at least one DC-DC converter.

5. The smart power microgrid as claimed in claim 1, wherein when the grid is a hybrid grid interfaced to a PMD(C), the PMD(C) is provided with one each submeter for metering'AVC. and D.C. supply respectively, including a combined converter.

6. The system as claimed in claim 1, wherein the central controller in communication with PMD controller is enabled to:

- a. measure the total output from the power generator;
- b. implement the process of maximum power point (MPP) tracking;
- c. assign an energy capacity to each fanouts and each PMDs based on the generation-consumption capacity;
- d. transmit signals to the fanouts to increase power consumption if the PMD is hot operating at MPP, or to reduce power consumption when consumption is higher than generation;
- e. prioritize each fanout based on their pre-allocation capacities, power generation, and power consumption at each point of time;
- f. prioritize each PMDs through the fanouts and transmit signals to the PMDs to increase or decrease power consumption based on generation-consumption status including pre-assigned capacities;
- g. allow the PMDs to consume excess power through charging of local storage or supply to the consumers when generation is higher, alternatively allow the PMDs to stop charging their internal storage including rationing the supply to the consumers when generation is lower than demand;
- h. measure the power-drawn under the increased power consumption scenario, and further measure consumption or otherwise of power from the central storage by the PMDs;
- i. measure the status of decrease in power consumption by the PMDs when consumption is higher than the generation;

j. transmit further command to the PMDs to continue increase their consumption under condition (viii), or stop supply of power to the PMDs when first decrease is not corresponding to lower generation and allow the PMDs to supply power to the consumers from their local storage.

7. The system as claimed in claim 1, wherein a plurality of power management units are provided in a stack to generate a variety of output voltages.

8. The system as claimed in claim 1, wherein the system is activated and deactivated for a fixed period of time by externally passing a waveform of a particular frequency, or specific commands readable by the system, and wherein after expiration of a fixed activated time, a power management device turns off automatically.

9. The system as claimed in claim 1, wherein the switches comprise MOSFETs that turns the power management units on or off.

10. The system as claimed in any of the preceding claims, wherein the variable energy generation source can be selected from a group consisting of solar panels, grid supply, micro wind generators, bicycle dynamos and micro hydro power plants.

11. A multipurpose power management system, comprising:

a singular or plurality of power management devices which can be individually or plurally activated and deactivated, and each of the power management devices being configured to be coupled to a variety of input energy sources;

a controller configured for providing regulated operational mechanisms,

a plurality of converters coupled to the battery of each power management unit and configured for providing output voltages that are accessible individually;

a plurality of sensing circuits to sense external signals and provide selective activation or deactivation of the system; and

a means for autonomously responding to the system when invasive measures occur due to an unwanted intrusion,

said plurality of PMDs are capable of communicating with each other and enable creation of a central grid power management system.

12. The system of claim 11, further comprising:

a system housing;

a microcontroller, as a specific type of controller, which control signals to provide for power management system's activation and/or deactivation of the devices through protection against theft detection and the overloading or short circuiting of the devices compromising the system;

a plurality of connectors positioned on a top and a bottom of the housing to stack the plurality of power management units for higher power output.

13. The system of claim 11, further comprising:

a plurality of signal filters that interpret communication signals used to decode activation, deactivation, or account balance recharge signals sent by an external device to the system.

14. The system of claim 11, wherein the charging controller with a comparator compares an output voltage of an individual power management unit to a reference voltage and modifications rendered based on predetermined standards.

15. The system of claim 11, wherein the one or more input energy sources charge the battery without required conversion or external voltage regulation.

16. The system of claim 13, wherein power management units may be configured to only charge themselves from a particular type of input energy source to enable secure rental through charging station businesses.

17. The system of claim 16, wherein in response to a power management unit being configured for a particular type of input energy then the power management unit do not charge from another input energy source.

18. The system of claim 11, wherein a plurality of power management devices are provided in a stack and generate a variety of output voltages

19. The system of claim 11, further comprising:

wherein said means of intrusion is through detection of power theft due tampering of the PMD or the power distribution network connecting the PMDs as one of the operational regulated mechanisms of the controller.

20. The system of claim 11, further comprising:

Remotely configurable power overload detection limits to prevent the PMD from allowing more than the configured power limit to flow through the PMD as one of the operational regulated mechanisms of the controller.

21. A multipurpose power management system, comprising:
a system housing;

a singular or plurality of power management devices which can be individually activated and deactivated, and each of the power management devices being configured to be coupled to a variety of input energy sources as part of a distributed storage network for a central grid structure;

a controller or series of controllers configured for providing the following capably regulated operational mechanisms

- a. charging the device's battery,
- b. grid theft detection,
- c. energy overload detection;

a plurality of convertors coupled to the battery of each power management unit and configured for providing output voltages that are accessible individually;

a user interface component to enable various information feed backs on the units and overall system;

a plurality of user switches for external activation and control;

a plurality of filters coupled to the battery to filter signals for activation/deactivation or recharging;

an ability for one or more input energy sources coupled to the system wherein selected at least one of from the following, solar panels, grid supply, micro wind generators, bicycle dynamos and micro hydro power plants;

a plurality of filters coupled to the battery to filter signals for activation/deactivation or recharging;

a reverse blocking diode coupled to the battery to prevent current from flowing from the battery to input energy sources;

one or more MOSFETs that turns the power management units on or off, and

a plurality of sensing circuits to sense external signals and provide selective activation or deactivation of the system.

22. A method for operating a multipurpose power management system, comprising:

implementation of a singular or plurality of power management devices which can be individually or plurality activated and deactivated, and each of a power management device being operationally configured to be coupled to a variety of input energy sources;

a step for using a controller or series of controllers configured for providing the following regulated operational mechanisms

a step for implementing a plurality of converters coupled to the battery of each power management unit and configured for providing output voltages that are accessible individually;

a step towards enabling and using a user interface component to enable various information feed backs on the units and overall system;

a step for using a plurality of user switches for external activation and control;

a step for use of a plurality of filters coupled to the battery to filter signals for activation/deactivation or recharging;

a step for implementing an ability for one or more input energy sources coupled to the system wherein selected at least one of from the following, solar panels, grid supply, micro wind generators, bicycle dynamos and micro hydro power plants;

a step for using a plurality of filters coupled to the battery to filter signals for activation/deactivation or recharging;

a step for allowing use of a reverse blocking diode coupled to the battery to prevent current from flowing from the battery to input energy sources;

a step for detection of unwanted tampering and theft from the system;

a step for implementing one or more MOSFETs that turns the power management units on or off, and

a step for using a plurality of sensing circuits to sense external signals and provide selective activation or deactivation of the system.

23. The method of claim 17 an operational regulated mechanism step is comprising:

of charging the power management device's battery by controlling the amount of power flowing into or out of the battery depending on the state of the battery and/or instructions communicated by the central controller.

24. The method of claim 19 an operational regulated mechanism step is comprising: of monitoring the system's grid from theft through a power management device.

25. The method of claim 14 an operational regulated mechanism step is comprising: of detecting energy overload on the individual devices and of the system as it relates to the micro power grid.

26. An automatized method of detecting presence and magnitude of tampering and power theft in a smart microgrid producing power and having at least one central controller and at least one power management device (PMD) having a microcontroller in communication with the central controller(s), the method comprising the steps of:

a. detection of unauthorized tampering with the PMD detection and transmission to the central controller(s) of the location of the tampering;

b. transmission of a signal to the appropriate devices in the system to shut down power in the area where the tamper took place till the tamper condition is not resolved;

c. automatic notification of any tampering to an authorized operator.

27. A process of automatically achieving the maximum power point tracking (MPPT) for variable power generation source in a smart microgrid having at least one central controller and a cluster of power management devices each having a microcontroller, the process comprising the steps of:

a. measuring the voltage and current of the power supply and measuring the power output of the power generators by multiplying the voltage and current;

b. measuring upon receipt of signal from the fanouts on the status of percentage power change by the PMDs, by the central controller;

c. computing and transmitting a signal through a controller to the fanouts for necessary modifications;

d. providing a central storage on the system with a metering means.