Claims

1. A power control device for use with one or more associated power units to provide a response to changes in a frequency of electricity flowing in a synchronous area of an electric power grid, wherein the electric power grid is connected to a measurement system arranged to determine a frequency response characteristic of the grid in said area and to determine one or more trigger parameters on the basis of the measured frequency response characteristic, the power control device being arranged to:

intermittently receive one or more parameters from the measurement system, the one or more parameters being derived from a said determined frequency response characteristic;

derive, on the basis of the received one or more parameters, a trigger condition;

determine, based on a measured frequency characteristic of electric power flowing in the grid, whether the trigger condition is satisfied; and

in response to a determination that the trigger condition is satisfied, change a power flow to and/or from the power unit,

wherein when the trigger condition being satisfied indicates a rise in grid frequency, changing the power flow comprises increasing a power flow to and/or reducing a power flow from the one or more power units,

and when the trigger condition being satisfied indicates a drop in grid frequency, changing the power flow comprises reducing a power to and/or increasing a power flow from the one or more power units.

2. A power control device according to claim 1, in which one of the received one or more parameters comprise said trigger condition.

3. A power control device according to claim 1 or claim 2, in which said frequency response characteristic comprises an inertia characteristic.

4. A power control device according to claim 1 or claim 2, in which said frequency response characteristic comprises a characteristic relating to a magnitude of variation in grid frequency per unit change in power balance.

5. A power control device according to any one of claims 1 to 4, arranged to:

define a first series of values associated with the frequency characteristic during a first time period and a second series of values associated with the frequency characteristic during a second, later, time period;

determine a first polynomial function having a first set of coefficients on the basis of said first series of values and a second polynomial function having a second set of coefficients on the basis of said second series of values; and

determine whether the trigger condition is satisfied on the basis of a difference between the first set of coefficients and the second set of coefficients.

6. A power control device according to claim 5, wherein the first and second polynomial functions are second order polynomial functions.

7. A power control device according to claim 5 or claim 6, in which the frequency change event is identified on the basis of a value of at least one coefficient of the second set of coefficients differing from a corresponding coefficient in the first set of coefficients by more than a predetermined amount.

8. A power control device according to any one of claim 5 to claim 7, arranged to measure said series of values according to a polynomial extrapolation technique and/or conic extrapolation technique.

9. A power control device according to any one of claim 1 to claim 8, comprising a detector (302) for measuring a frequency characteristic.

10. A power control device according to any one of claims 1 to 9, comprising phasor measurement instrumentation arranged to measure said measured frequency characteristic on the basis of a phasor measurement.

11. A power control device according to claim 10, in which the phasor measurement instrumentation is arranged to measure a phase associated with a vector of voltage measured in the electric power grid with reference to an absolute time reference.

12. A power control device according to any one of claim 1 to claim 11, wherein the measured frequency characteristic includes one or more of: a frequency of alternating voltage, a frequency of alternating current, a frequency of power flowing in the electric power grid; a rate of change of frequency; and a period of alternating current.

13. A power control device according to any one of claim 1 to claim 12, arranged to receive a signal, said signal indicating a time period during which power flow may be controlled.

14. A power control device according to any one of claims 1 to 13, in which the power modulation comprises modulation of at least one of real power and reactive power.

15. A power control device according to any one of claims 1 to 14, in which said trigger condition is a level of the measured frequency characteristic or is based on one or more parameters relating to a fitting function applied to the measured frequency characteristic, or changes to the one or more parameters.

16. A system for responding to changes of frequency in an electric power grid, the system comprising:

a distributed plurality of power control devices according to any one of claim 1 to claim 15, each controlling a respective power unit connected to the electric power grid; and

a measurement system for transmitting one or more trigger parameters to each of the plurality of distributed power control devices.

17. A system according to claim 16, wherein the measurement system is arranged to:

define, a plurality of groups of power control devices from said distributed plurality of power control devices;

assign different respective trigger conditions to each of the plurality of groups; and

transmit, to each of power control devices a trigger condition assigned to the group to which it is assigned.

18. A system according to claim 17, wherein the measurement system is arranged to:

access a power unit database storing profile information relating to the consumption and/or provision of power by the power units associated with the power control devices; and

define said plurality of groups on the basis of the accessed profile information.

19. A system according to claim 16, wherein the measurement system is arranged to:

receive data indicative of a polynomial function representative of a measured frequency characteristic;

extrapolate, based on said polynomial function, future expected values associated with the measured frequency characteristic; and

determine, on the basis of the extrapolated future expected values, an expected power flow requirement for responding to the frequency change event.

20. A system according to claim 19, wherein the measurement system is arranged to:

access a power unit database comprising profile information relating to the consumption and/or provision of power by the power units;

define, on the basis of the expected power flow requirement and said profile information, one or more groups of one or more power units for responding to the frequency change event.

21. A system according to claim 20, wherein the measurement system is arranged to transmit one or more requests, for receipt at the power control devices of the defined groups, to control consumption and/or provision of electrical power by the power units associated with power control devices, thereby varying a net consumption of electrical energy in said area.