

CLAIMS

What is claimed is:

1. A radio frequency (RF) generator comprising:
 - 5 a RF power source generating an output signal including a RF signal modulated by a pulse that varies in accordance with power to be delivered to a load; and
 - a controller configured to control the pulse to include a plurality of states, wherein
 - 10 in a first state of the pulse, the controller is configured to control the RF generator to output the RF signal at a first power value and to control a frequency of the RF signal to a first frequency to vary an impedance between the RF generator and the load; and
 - in a second state of the pulse, the controller is further configured in at least one of the following modes to:
 - (a) control the RF generator to output the RF signal at a second power value and control the frequency of the RF signal irrespective of the impedance between the RF generator and the load, wherein the first power value is a burst power and the second power value is a working power;
 - (b) control the RF generator to output the RF signal at the second power value and control the frequency of the RF signal to vary the impedance between the RF generator and the load, wherein the first power value is the burst power and the second power value is the working power;
 - (c) control the RF generator to output the RF signal at the second power value and control the frequency of the RF signal irrespective of the impedance between the RF generator and the load, wherein the first power value exceeds the second power value; or
 - (d) control the RF generator to output the RF signal at the second power value and control the frequency of the RF signal to vary the impedance between the RF generator and the load, wherein the first power value exceeds the second power value.
2. The RF generator of claim 1 wherein when the controller is configured in one of modes (b) and (d), the frequency of the RF signal varies within a range of the frequency in accordance with the impedance between the RF generator and the load.

3. The RF generator of claim 1 wherein when the controller is configured in one of modes (a) and (b), the first power value exceeds a boundary of the pulse and the second power value is bounded by the pulse.

4. The RF generator of claim 1 wherein the first state of the pulse and the second state of the pulse occur relative to a start of the pulse, and the first state of the pulse occurs at the start of the pulse and the second state of the pulse occurs following completion of the first state of the pulse.

5. The RF generator of claim 1 wherein the controller is further configured to output a signal to initiate operation of a matching network between the RF generator and the load.

6. The RF generator of claim 1 wherein when the controller is configured in one of modes (a) and (c), the controller is further configured to apply gamma blanking when outputting the first power value.

7. The RF generator of claim 1 wherein the first state of the pulse includes a plurality of bins, and the controller is configured to control the RF generator for each bin to output the first frequency in accordance with a selected frequency associated with each of the plurality of bins, wherein the selected frequency associated with each of the plurality of bins varies for at least a pair of the plurality of bins.

8. The RF generator of claim 7 wherein the controller is configured to control the RF generator for each of the plurality of bins to output the first power value in accordance with a selected power value associated with each of the plurality of bins, wherein the selected power value associated with each bin varies for at least a pair of the plurality of bins.

9. The RF generator of claim 7 wherein the selected frequency associated with each of the plurality of bins for a next pulse is updated in accordance with at least one of the impedance match between the RF generator and the load and power delivered to the load for at least one prior pulse.

10. The RF generator of claim 7 wherein the selected frequency associated with each of the plurality of bins for a next pulse is updated in accordance with varying the frequency linearly within each of the plurality of bins and adjusting a slope and offset of a line defining a variation of the frequency to minimize the impedance between the RF generator and the load.

5 11. The RF generator of claim 1 wherein the controller is further configured to control the pulse to include a third state of the pulse in which the controller is configured to control the RF generator to output the RF signal at a third power value and to control the frequency of the RF signal to a second frequency, wherein at least one of the third power value is not equal to one of the first power value or the second power value and the second frequency is not equal to the first frequency.

10 12. A radio frequency (RF) generator system comprising:
a RF power source generating an output signal including a RF signal modulated by a pulse that varies in accordance power to be delivered to a load, wherein the pulse includes a plurality of states; and

a controller configured to control the RF generator, wherein
15 in a first state of the pulse including a plurality of bins, the controller is configured to ~~(a)~~ control the RF generator to output a plurality of frequencies within each bin, and the controller is configured to control the RF generator to output the RF signal at at least one first power value; and
in a second state of the pulse, the controller is further configured ~~in a mode (a)~~ to control the RF generator to output the RF signal at a second power value (mode (a)).

20 13. The RF generator system of claim 12 wherein the at least one first power value and the second power value are bounded by the pulse.

14. The RF generator system of claim 12 wherein the at least one first power value is a burst power and the second power value is a working power, and the burst power exceeds a boundary of the pulse and the second power value are bounded by the pulse.

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15. The RF generator system of claim 12 wherein in the second state of the pulse, the controller is further configured in at least one of the following modes to:

(a) further control the RF generator to output a plurality of frequencies within each bin to a plurality of preselected frequencies;

5 (b) control the RF generator to output the RF signal at the second power value and control the respective frequency associated with each of the plurality of bins to vary impedance between the RF generator and the load, wherein the first power value is a burst power and the second power value is a working power;

(c) control the RF generator to output a plurality of frequencies within each bin to a plurality of preselected frequencies, wherein the first power value exceeds the second power value; or

(d) control the RF generator to output the RF signal at the second power value and control the respective frequency associated with each of the plurality of bins to vary the impedance between the RF generator and the load, wherein the first power value exceeds the second power value.

16. The RF generator system of claim 15 wherein when the controller is configured in one of modes (c) and (d), the at least one first power value and the second power value are bounded by the pulse.

17. The RF generator system of claim 15 wherein when the controller is configured in one of modes (a) and (b), the at least one first power value exceeds a boundary of the pulse and the second power value is bounded by the pulse.

20 18. The RF generator system of claim 15 wherein when the controller is configured in one of modes (a) and (c), the controller is further configured to apply gamma blanking while outputting the at least one first power value.

19. The RF generator system of claim 15 wherein when the controller is configured in one of modes (b) and (d), the plurality of frequencies within each bin varies within a range of each
25 respective frequency in accordance with the impedance between the RF generator and the load.

20. The RF generator system of claim 12 wherein the first state [of the pulse](#) and the second state [of the pulse](#) occur relative to a start of the pulse, and the first state [of the pulse](#) occurs at the start of the pulse and the second state [of the pulse](#) occurs following completion of the first state [of the pulse](#).

5 21. The RF generator system of claim 12 wherein the controller is further configured to output a signal to initiate operation of a matching network between the RF generator and the load.

22. The RF generator system of claim 12 wherein the controller is configured to control the RF generator to output a plurality of power values within each bin, wherein the plurality of power values varies for at least a pair of the plurality of bins.

10 23. The RF generator system of claim 12 wherein the plurality of frequencies within each bin for a next pulse is updated in accordance with at least one of an impedance between the RF generator and the load and power delivered to the load for at least one prior pulse.

24. The RF generator system of claim 12 wherein the plurality of frequencies within each bin for a next pulse is updated in accordance with varying the frequency within each bin linearly and
15 adjusting a slope and offset of a line defining a variation of the frequency to minimize an impedance between the RF generator and the load.

25. The RF generator system of claim 12 wherein the controller is further configured to control the pulse to include a third state [of the pulse](#) in which the controller is configured to control the RF generator to output the RF signal at a third power value and to control the frequency of the
20 RF signal to a second frequency, wherein at least one of the third power value is not equal to one of the first power value or the second power value and the second frequency is not equal to the respective frequency associated with each of the plurality of bins.

26. A controller configured to control a pulse output by a RF power source, wherein the RF power source generates an output signal including a RF signal modulated by a pulse that varies in accordance power to be delivered to a load, wherein

5 a first state, the controller is configured to control the RF generator to output the RF signal at a first power value and to control a frequency of the RF signal to a first frequency to vary an impedance between the RF generator and the load; and

10 in a second state, the controller is further configured in a mode (a) to control the RF generator to output the RF signal at a second power value and control the frequency of the RF signal irrespective of the impedance between the RF generator and the load, wherein the first power value is a burst power and the second power value is a working power.

27. The controller of claim 26 further configured to in one of mode (a) or the following modes:

15 (b) control the RF generator to output the RF signal at the second power value and control the first frequency of the RF signal to vary the impedance between the RF generator and the load, wherein the first power value is the burst power and the second power value is the working power;

(c) control the RF generator to output the RF signal at the second power value and control the first frequency of the RF signal irrespective of the impedance between the RF generator and the load, wherein the first power value exceeds the second power value; or

20 (d) control the RF generator to output the RF signal at the second power value and control the first frequency of the RF signal to vary the impedance between the RF generator and the load, wherein the first power value exceeds the second power value.

28. The controller of claim 27 wherein in modes (b) and (d), the frequency of the RF signal varies within a range of the first frequency in accordance with the impedance between the RF generator and the load.

25 29. The controller of claim 27 wherein in modes (a) and (b), the first power value exceeds a boundary of the pulse and the second power value is bounded by the pulse.

30. The controller of claim 27 wherein the first state and the second state occur relative to a start of the pulse, and the first state occurs at the start of the pulse and the second state occurs following completion of the first state.

31. The controller of claim 26 wherein the first state includes a plurality of bins, and the controller is configured to control the RF generator for each bin to output the first frequency in accordance with a selected frequency associated with each of the plurality of bins, wherein the selected frequency associated with each of the plurality of bins varies for at least a pair of the plurality of bins.

32. The controller of claim 31 wherein the controller is configured to control the RF generator for each of the plurality of bins to output the first power value in accordance with a selected power value associated with each of the plurality of bins, wherein the selected power value associated with each of the plurality of bins varies for at least a pair of the plurality of bins.

33. The controller of claim 32 wherein the selected frequency associated with each of the plurality of bins for a next pulse is updated in accordance with at least one of the impedance match between the RF generator and the load and power delivered to the load for at least one prior pulse.

34. A method for controlling power delivery to a load comprising:
controlling a RF power generator to generate a RF output signal modulated by a pulse to vary power delivered to the load;
in a first state, controlling the RF generator to output the RF signal at a first power value at a first frequency to vary an impedance between the RF generator and the load; and
in a second state, controlling in a mode (a) to output the RF signal at a second power value and control the frequency of the RF signal irrespective of the impedance between the RF generator and the load, wherein the first power value is a burst power and the second power value is a working power.

35. The method of claim 34 wherein in the second state, controlling to one of mode (a) or the following modes:

(b) to output the RF signal at the second power value and control the frequency of the RF signal to vary the impedance between the RF generator and the load, wherein the first power value
5 is the burst power and the second power value is the working power;

(c) to output the RF signal at the second power value and control the frequency of the RF signal irrespective of the impedance between the RF generator and the load, wherein the first power value exceeds the second power value; or

(d) to output the RF signal at the second power value and control the frequency of the RF
10 signal to vary the impedance between the RF generator and the load, wherein the first power value exceeds the second power value.

36. The method of claim 35 wherein the first state and the second state occur relative to a start of the pulse, and the first state occurs at the start of the pulse and the second state occurs following completion of the first state.

15 37. The method of claim 34 wherein the first state includes a plurality of bins, and the controller is configured to control the RF generator for each bin to output the first frequency in accordance with a selected frequency associated with each of the plurality of bins, wherein the selected frequency associated with each of the plurality of bins varies for at least a pair of the plurality of bins.

20 38. The method of claim 37 wherein the controller is configured to control the RF generator for each of the plurality of bins to output the first power value in accordance with a selected power value associated with each of the plurality of bins, wherein the selected power value associated with each of the plurality of bins varies for at least a pair of the plurality of bins.

25 39. The method of claim 38 wherein the selected frequency associated with each of the plurality of bins for a next pulse is updated in accordance with at least one of the impedance match between the RF generator and the load and power delivered to the load for at least one prior pulse.