CLAIMS

We claim:

1. A pulse width modulation (PWM) generator, comprising,

a phase-shifting circuit ~~have~~having at least one input and ~~a plurality of~~ two or more outputs, said phase-shifting circuit configured to receive a sinusoidal reference signal and in response thereto provide a phase-shifted signal on each of said two or more outputs, each phase-shifted signal having a predetermined phase shift relative to the reference signal; and

a waveform combiner having a plurality of inputs with each input coupled to a respective one of the ~~plurality of~~ two or more outputs of said phase-shifting circuit, said waveform combiner configured to receive phase-shifted signals from said phase-shifting circuit at inputs thereof and in response thereto, generate a PWM signal having a predetermined pulse width and phase-shift relative to the reference signal, wherein the predetermined phase shift is between a rising edge of the PWM signal and a negative-to-positive transition of the reference signal.

2. The PWM generation circuit of claim 1, wherein said phase-shifting circuit comprises a plurality of phase-shifting elements coupled in a parallel architecture.

3. The PWM generation circuit of claim 1, wherein said phase-shifting circuit comprises a plurality of phase-shifting elements coupled in a cascaded architecture.

4. The PWM generation circuit of claim 1, wherein said phase-shifting circuit comprises at least one in-phase/quadrature-phase (IQ) modulator having at least three inputs and at least one output with at least one of said inputs configured to receive the reference signal and at least two of said inputs configured to receive baseband signals derived from the reference signal, said IQ modulator comprising an adder coupled between the output and at least two inputs.

5. The PWM generation circuit of claim 1, wherein the waveform combiner comprises at least one of: an edge detector; a logic gate; a flip-flop; or an amplifier.

6. The PWM generator of claim 5, wherein the waveform combiner comprises:

a plurality of amplifiers having an input and an output, each input of said amplifiers configured to receive a phase-shifted signal; and

a logic gate having a plurality of inputs and at least one output, each input of said waveform combiner configured to be coupled to the output of at least one amplifier.

7. The PWM generation circuit of claim 1, wherein the phase-shifting circuit is configured to generate two or more phase shifted signals based upon at least one predetermined phase-shift parameter.

8. The PWM generation circuit of claim 7, wherein the phase-shifting circuit is further configured to receive the at least one predetermined phase-shift parameter from a controller.

9. The PWM generation circuit of claim 8, where in the controller in configured to generate the at least one predetermined phase-shift parameter based upon the pulse width and phase-shift relative to the reference signal of the generated PWM signal.

10. The PWM generation circuit of claim 1, wherein the PWM generation circuit is realized in an integrated circuit.

11. An apparatus for generating dynamically controlled pulse width modulation (PWM) signals, comprising:

two or more phase-shifting elements each having an input and output with the input of each phase-shifting element configured to receive a reference signal wherein each phase-shifting element is configured to

generate a respective phase-shifted signal at its output based upon the reference signal and a phase-shift parameter provided thereto; and

a waveform combiner having inputs coupled to the outputs of the phase-shifting elements and configured to combine phase-shifted signals provided thereto from the outputs of the phase-shifting elements to generate a PWM signal having a pulse width and phase shift based upon a characteristic of the reference signal and the phase-shift parameter, wherein the predetermined phase shift is between a rising edge of the PWM signal and a negative-to-positive transition of the reference signal.

12. The apparatus of claim 11, wherein each predetermined phase-shift parameter comprises at least one of:

a predetermined phase shift; or

a predetermined pulse width.

13. The apparatus of claim 11, wherein at least one of the phase-shifting elements comprises an in-phase/quadrature-phase (IQ) modulator.

14. The apparatus of claim 11, wherein at least one of the phase-shifting elements comprises a phase-lock loop.

15. The apparatus of claim 11, wherein each phase-shifting element is coupled to receive a respective one of a plurality of control signals, each respective control signal comprising the respective predetermined phase shift parameter.

16. The apparatus of claim 15, wherein the apparatus further comprises a phase detector coupled to the reference signal and the generated PWM signal.

17. The apparatus of claim 16, wherein the phase detector is configured to generate a phase correction signal based upon a comparison of the

reference signal to the generated PWM signal and wherein said phase correction signal is provided to each phase-shifting element.

18. The apparatus of claim 11, wherein the waveform combiner comprises at least one edge detector, each edge detector being coupled to at least one flip-flop.

19. The apparatus of claim 18, wherein the at least one flip-flop is configured to generate the PWM signal based upon a rising edge of at least one generated phase-shifted signal and a rising edge of at least one other generated phase-shifted signal.

20. A method for generating dynamically controlled pulse width modulation (PWM) waveforms, comprising:

receiving a reference signal at one or more phase-shifting elements, each phase-shifting element having a respective predetermined phase shift parameter;

generating respective phase-shifted signals at outputs of the one or more phase-shifting elements based upon the reference signal and the respective predetermined phase shift parameters;

combining the generated phase-shifted signals to obtain a PWM waveform having a pulse width and phase shift based upon the predetermined phase shift parameters of the phase-shifting elements, wherein the predetermined phase shift parameters determine a phase shift between a rising edge of the PWM waveform and a negative-to-positive transition of the reference signal.

21. The method of claim 20, wherein each respective predetermined phase shift parameter comprises at least one of a respective predetermined phase shift or respective predetermined pulse width.

22. The method of claim 20, further comprising:

providing a respective control signal to each phase-shifting element,

the control signal comprising the respective predetermined phase shift parameter.

23. The method of claim 20, further comprising:

generating a phase correction signal based upon a comparison of the reference signal to the PWM waveform.

24. The method of claim 20, further comprising:

adjusting the generated phase-shifted signals based upon ~~the~~a phase correction signal.

~~25. A power generation and delivery system having an input port and an output port, power generation and delivery system comprising:~~

~~a pulse width modulation (PWM) signal generator comprising one or more phase-shifting elements and waveform combiner having inputs coupled to outputs of said phase-shifting elements, said PWM signal generator configured to generate a PWM signal based upon a phase-shift parameter associated with the one or more phase-shifting elements; and~~

~~a phase-switched tunable impedance network coupled to the output port and configured to receive a generated PWM signal from the PWM signal generator, said phase-switched tunable impedance network configured such that in response to a generated PWM signal, the phase-switched tunable impedance network varies an impedance thereof to modulate an impedance presented to the output port.~~

~~26. The power generation and delivery system of claim 25, wherein the one or more phase-shift elements are coupled in a parallel architecture.~~

~~27. The power delivery and power system of claim 25, wherein the one or more phase-shift elements are coupled in a cascading architecture.~~

28. The power delivery and power system of claim 25 further comprising a controller coupled to said PWM signal generator, said controller configured to store phase-shift parameters and configured to provide one or more phase-shift parameters to said PWM to produce a PWM signal having at least one of a predetermined phase shift or a predetermined pulse width.

29. The power delivery and power system of claim 25, wherein at least one of the phase-shifting elements comprises one of:

    a. an In-phase/Quadrature (IQ) modulator; and

    b. a phase lock loop.

30. The power delivery and power system of claim 25, wherein said waveform combiner comprises at least one of:

    a. one or more logic gates, said at least one logic gate configured to compare the first and second phase-shifted signals;

    b. two or more mixers configured to receive respective ones of I, Q signals and having outputs coupled to respective inputs of a sum circuit; or

    c. two to more edge detector circuits having inputs configured to receive respective ones of two or more phase-shifted signals and having outputs coupled different inputs of a flip-flop.