

WHAT IS CLAIMED IS:

1. An envelope tracking system comprising:
 - a power amplifier configured to amplify a radio frequency signal and to receive power from a power amplifier supply voltage; and
 - an envelope tracker configured to generate the power amplifier supply voltage based on an envelope signal corresponding to an envelope of the radio frequency signal, the envelope tracker including a DC-to-DC converter configured to output a plurality of regulated voltages, a modulator configured to generate a modulator output voltage based on the plurality of regulated voltages and the envelope signal, a first filter coupled between the modulator output voltage and the power amplifier supply voltage, and a second filter coupled between a DC voltage and the power amplifier supply voltage.
2. The envelope tracking system of claim 1 wherein the DC-to-DC converter is further configured to generate the DC voltage.
3. The envelope tracking system of claim 1 wherein each of the plurality of regulated voltages has a different voltage level.
4. The envelope tracking system of claim 1 wherein the modulator includes a plurality of switches each coupled between the modulator output voltage and a corresponding one of the plurality of regulated voltages.
5. The envelope tracking system of claim 1 wherein the first filter includes at least one series inductor and at least one shunt capacitor.
6. The envelope tracking system of claim 5 wherein the first filter further includes a DC blocking capacitor in series between the modulator output voltage and the power amplifier supply voltage.
7. The envelope tracking system of claim 1 wherein the second filter includes at least one series inductor and at least one shunt capacitor.

8. The envelope tracking system of claim 1 wherein the envelope tracker further includes a controllable delay circuit configured to control a relative delay between an AC path through the first filter and a DC path through the second filter.

9. The envelope tracking system of claim 8 wherein the controllable delay circuit includes a plurality of controllable delay buffers each configured to control a delay of a respective one of the plurality of regulated voltages.

10. The envelope tracking system of claim 1 wherein a DC path through the second filter carries at least seventy five percent of the energy provided from the envelope tracker to the power amplifier.

11. A mobile device comprising:

a transceiver configured to generate a radio frequency transmit signal;

a front end circuit including a power amplifier configured to amplify the radio frequency transmit signal and to receive power from a power amplifier supply voltage; and

a power management circuit including an envelope tracker configured to generate the power amplifier supply voltage based on an envelope signal corresponding to an envelope of the radio frequency transmit signal, the envelope tracker including a DC-to-DC converter configured to output a plurality of regulated voltages, a modulator configured to generate a modulator output voltage based on the plurality of regulated voltages and the envelope signal, a first filter coupled between the modulator output voltage and the power amplifier supply voltage, and a second filter coupled between a DC voltage and the power amplifier supply voltage.

12. The mobile device of claim 11 wherein the DC-to-DC converter is further configured to generate the DC voltage.

13. The mobile device of claim 11 further comprising a battery that provides a battery voltage, the DC-to-DC converter configured to generate the plurality of regulated voltages and the DC voltage based on providing DC-to-DC conversion of the battery voltage.

14. The mobile device of claim 11 wherein the first filter includes at least one series inductor, at least one shunt capacitor, and a DC blocking capacitor in series between the modulator output voltage and the power amplifier supply voltage.

15. The mobile device of claim 11 wherein the envelope tracker further includes a controllable delay circuit configured to control a relative delay between an AC path through the first filter and a DC path through the second filter.

16. The mobile device of claim 15 wherein the controllable delay circuit includes a plurality of controllable delay buffers each configured to control a delay of a respective one of the plurality of regulated voltages.

17. A method of envelope tracking, the method comprising:
 amplifying a radio frequency signal using a power amplifier;
 supplying power to the power amplifier using a power amplifier supply voltage;
 outputting a plurality of regulated voltages from a DC-to-DC converter;
 generating a modulator output voltage based on the plurality of regulated voltages and an envelope signal using a modulator, the envelope signal corresponding to an envelope of the radio frequency signal;
 controlling the power amplifier supply voltage using a first filter that is between the modulator output voltage and the power amplifier supply voltage; and
 controlling the power amplifier supply voltage using a second filter that is between a DC voltage and the power amplifier supply voltage.

18. The method of claim 17 further comprising generating the DC voltage using the DC-to-DC converter.

19. The method of claim 17 further comprising providing DC blocking using a series DC blocking capacitor of the first filter.

20. The method of claim 17 further comprising controlling a relative delay between an AC path through the first filter and a DC path through the second filter using a controllable delay circuit.