APPARATUS AND METHODS FOR BIAS SWITCHING OF POWER AMPLIFIERS

BACKGROUND

Field

[0001] Embodiments of the invention relate to electronic systems, and in particular, to power amplifiers for radio frequency (RF) electronics.

Description of the Related Technology

[0002] Power amplifiers are used in radio frequency (RF) communication systems to amplify RF signals for transmission via antennas. It can be important to manage the power of RF signal transmissions to prolong battery life and/or provide a suitable transmit power level.

[0003] Examples of RF communication systems with one or more power amplifiers include, but are not limited to mobile phones, tablets, base stations, network access points, laptops, and wearable electronics. Power amplifiers provide amplification to RF signals, which can have a frequency in the range from about 30 kHz to 300 GHz, for instance, in a range from about 450 MHz to about 90 GHz for certain communication standards.

SUMMARY

[0004] In a first aspect, the present disclosure provides a mobile device comprising: a power amplifier configured to amplify a radio frequency signal; a power management circuit configured to control a voltage level of a supply voltage of the power amplifier; the power management circuit operable in a selected supply control mode chosen from a plurality of supply control modes; and a bias control circuit is configured to switch a bias of the power amplifier based on the selected supply control mode of the power management circuit.

[0005] In a number of embodiments, the plurality of supply control modes includes an average power tracking mode and an envelope tracking mode.

[0006] In some embodiments, the bias control circuit is operable to control a bias impedance of the power amplifier based on the selected supply control mode.

[0007] In various embodiments, the bias control circuit is configured to receive a control signal indicating the selected supply control mode of the power

management circuit. According to several embodiments, the bias control circuit is configured to receive the control signal over a serial interface. In accordance with a number of embodiments, the serial interface is a mobile industry processor interface radio frequency front-end bus.

[0008] In some embodiments, the power amplifier includes a plurality of bias networks, the bias control circuit is operable to control the plurality of bias networks based on the selected supply control mode. According to a number of embodiments, the bias control circuit selectively activates different combinations of the plurality of bias networks based on the selected supply control mode. In accordance with various embodiments, the plurality of bias networks includes a first bias network activated in a first supply control mode and deactivated in a second supply control mode. According to several embodiments, the first bias network includes at least one of an amplitude distortion compensation circuit or a phase distortion compensation circuit.

[0009] In various embodiments, the power amplifier includes a first stage and a second stage subsequent to the first stage. In accordance with a number of embodiments, the power amplifier includes a first plurality of bias networks configured to bias the first stage, and a second plurality of bias networks configured to bias the second stage, and the bias control circuit is operable to control the first plurality of bias networks and the second plurality of bias networks based on the selected supply control mode. According to several embodiments, the bias control circuit selectively activates different combinations of the first plurality of bias networks and the second plurality of bias networks based on the selected supply control mode

[0010] In a second aspect, the present disclosure provides a packaged module comprising: a package substrate; a supply pin configured to receive a supply voltage from an external power management circuit; a first die attached to the package substrate and including a power amplifier configured to amplify a radio frequency signal; and a second die attached to the package substrate and including a bias control circuit configured to switch a bias of the power amplifier based on a control signal indicating a selected mode of controlling the supply voltage.

[0011] In various embodiments, the selected supply control mode indicates one of an average power tracking mode or an envelope tracking mode.

[0012] In several embodiments, the bias control circuit is operable to control a bias impedance of the power amplifier based on the selected supply control mode.

[0013] In a number of embodiments, the first die and the second die are implemented in different processing technologies. According to several embodiments, the first die is a gallium arsenide die and the second die is a complementary metal oxide semiconductor die or silicon on insulator die.

[0014] In various embodiments, the second die includes a serial interface configured to receive the control signal. In accordance with several embodiments, the serial interface is a mobile industry processor interface radio frequency front-end bus.

[0015] In some embodiments, the power amplifier includes a plurality of bias networks, and the bias control circuit is operable to control the plurality of bias networks based on the selected supply control mode. According to a number of embodiments, the bias control circuit selectively activates different combinations of the plurality of bias networks based on the selected supply control mode. In accordance with various embodiments, the plurality of bias networks includes a first bias network activated in a first supply control mode and deactivated in a second supply control mode. According to several embodiments, the first bias network includes at least one of an amplitude distortion compensation circuit or a phase distortion compensation circuit.

[0016] In a number of embodiments, the power amplifier includes a first stage and a second stage subsequent to the first stage. In accordance with several embodiments, the power amplifier includes a first plurality of bias networks configured to bias the first stage, and a second plurality of bias networks configured to bias the second stage, and the bias control circuit is operable to control the first plurality of bias networks and the second plurality of bias networks based on the selected supply control mode. According to various embodiments, the bias control circuit selectively activates different combinations of the first plurality of bias networks and the second plurality of bias networks based on the selected supply control mode

[0017] In a third aspect, the present disclosure provides a method of power amplifier biasing, the method comprising: amplifying a radio frequency signal using a power amplifier; controlling a voltage level of a supply voltage of the power amplifier using a power management circuit; operating the power management circuit in a selected supply control mode chosen from a plurality of supply control modes; and switching a bias of the power amplifier based on the selected supply control mode using a bias control circuit.