LOAD-MODULATED PUSH-PULL POWER AMPLIFIER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Application Serial No. 63/221,085, titled "LOAD MODULATED PUSH PULL POWER AMPLIFIER," filed on July 13, 2021, which is hereby incorporated by reference in its entirety.

BACKGROUND

1. Field of the Disclosure

At least one example in accordance with the present disclosure relates generally to power amplifiers.

2. Discussion of Related Art

Electronic devices, such as mobile cellular devices, may exchange information with other electronic devices. A mobile cellular device may include an antenna to transmit and receive signals. Mobile cellular devices may include additional components and circuitry to process signals transmitted and received via the antenna. For example, a mobile cellular device may include one or more power amplifiers to amplify a signal transmitted or received via the antenna.

SUMMARY

According to at least one example of the present disclosure, a power amplifier is provided comprising an input to receive an input signal, an output to provide an amplified output signal, a balun coupled between the input and the output, at least one capacitor coupled to the balun, and a controllable load coupled to the at least one capacitor and being configured to present, with the at least one capacitor, a variable impedance to the balun.

In one aspect, the present disclosure refers to a power amplifier comprising an input configured to receive an input signal, and an input split configured to transform the input signal into a balanced signal, an input driver coupled between the input and the input split, an output configured to provide an amplified output signal, a balun coupled to the output, an output driver being coupled between the input driver and the balun, at least one capacitor coupled to the balun, and a controllable load coupled to the at least one capacitor and being configured to present, with the at least one capacitor, a variable impedance to the balun.

In various examples, the controllable load includes a switch. In at least one example, the switch includes a heterojunction bipolar transistor. In some examples, the power amplifier includes an input split configured to transform the input signal to a balanced signal, an input driver coupled between the input and the input split, and an output driver coupled between the input driver and the balun. In various examples, the power amplifier includes an interstage match between the input driver and the output driver configured such that a collector impedance of the input driver is out-of-phase with a collector impedance of the output driver.

In at least one example, increasing the controllable load increases a gain and a saturation power of the power amplifier. In some examples, increasing the controllable load increases the collector impedance of the input driver and decreases a collector impedance of the output driver. In various examples, the controllable load is a variable resistance. In at least one example, the input driver includes a cascode amplifier. In some examples, the input driver includes a common-emitter amplifier. In various examples, the output driver includes a common-emitter amplifier. In at least one example, the controllable load is a variable resistance.

According to at least one example of the disclosure, a method of controlling a power amplifier is provided comprising providing a power amplifier having a balun, at least one capacitor coupled to the balun, and a controllable load coupled to the at least one capacitor, and varying the controllable load to improve an efficiency of the balun.

In another aspect, the present disclosure refers to a method of controlling a power amplifier comprising providing a power amplifier having a balun, at least one capacitor coupled to the balun, an input split, an input driver coupled between the input and the input split, an output driver coupled between the input driver and the balun, and a controllable load coupled to the at least one capacitor, transforming the input signal into a balanced signal at the input split, and varying the controllable load to improve an efficiency of the balun.

In at least one example, the controllable load includes a switch, and varying the controllable load includes varying a control signal provided to a control connection of the switch. In some examples, the controllable load includes a variable resistor, and varying the controllable load includes varying a resistance of the variable resistor. In various examples, the power amplifier further includes an input driver and an output driver, and the method further includes implementing an interstage match between the input driver and the output driver such that a collector impedance of the input driver is out-of-phase with a collector impedance of the output driver. In at least one example, increasing the controllable load increases the collector impedance of the input driver and decreases a collector impedance of the output driver. In some examples, increasing the controllable load includes increasing a resistance of the controllable load.

According to at least one example of the disclosure, a power-amplifier system is provided comprising an input to receive an input signal, an output to provide an amplified output signal, a balun coupled between the input and the output, at least one capacitor coupled to the balun, and means for varying a load coupled to the at least one capacitor.

In at least one example, the power-amplifier system includes means for simultaneously increasing a gain of the power-amplifier system and a saturated power point of the power-amplifier system.

BRIEF DESCRIPTION OF THE DRAWINGS

CLAIMS

1. A power amplifier comprising:

an input configured to receive an input signal, and an input split configured to transform the input signal into a balanced signal;

an input driver coupled between the input and the input split;

an output configured to provide an amplified output signal;

a balun coupled to the output, an output driver being coupled between the input driver and the balun;

at least one capacitor coupled to the balun; and

a controllable load coupled to the at least one capacitor and being configured to present, with the at least one capacitor, a variable impedance to the balun.

2. The power amplifier of claim 1 wherein the controllable load includes a switch.

3. The power amplifier of claim 2 wherein the switch includes a heterojunction bipolar transistor.

4. The power amplifier of any preceding claim further comprising an interstage match between the input driver and the output driver configured such that a collector impedance of the input driver is out-of-phase with a collector impedance of the output driver.

5. The power amplifier of claim 4 wherein increasing the controllable load increases a gain and a saturation power of the power amplifier.

6. The power amplifier of claim 5 wherein increasing the controllable load increases the collector impedance of the input driver and decreases a collector impedance of the output driver.

7. The power amplifier of claim 6 wherein the controllable load is a variable resistance.

8. The power amplifier of any preceding claim wherein the input driver includes a cascode amplifier.

9. The power amplifier of any preceding claim wherein the input driver includes a common-emitter amplifier.

10. The power amplifier of any preceding claim wherein the output driver includes a common-emitter amplifier.

11. The power amplifier of any preceding claim wherein the controllable load is a variable resistance.

12. The power amplifier of claim 1 further comprising means for simultaneously increasing a gain of the power-amplifier system and a saturated power point of the power-amplifier system.

13. A method of controlling a power amplifier comprising:

providing a power amplifier having a balun, at least one capacitor coupled to the balun, an input split, an input driver coupled between the input and the input split, an output driver coupled between the input driver and the balun, and a controllable load coupled to the at least one capacitor;

transforming the input signal into a balanced signal at the input split; and

varying the controllable load to improve an efficiency of the balun.

14. The method of claim 13 wherein the controllable load includes a switch, and wherein varying the controllable load includes varying a control signal provided to a control connection of the switch.

15. The method of claim 14 wherein the controllable load includes a variable resistor, and wherein varying the controllable load includes varying a resistance of the variable resistor.

16. The method of claim 14 further comprising implementing an interstage match between the input driver and the output driver such that a collector impedance of the input driver is out-of-phase with a collector impedance of the output driver.

17. The method of claim 16 wherein increasing the controllable load increases the collector impedance of the input driver and decreases a collector impedance of the output driver.

18. The method of claim 17 wherein increasing the controllable load includes increasing a resistance of the controllable load.