AGGREGATE SIGNAL AMPLIFICATION DEVICE AND METHOD

BACKGROUND

Field of the Invention

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

Description of the Related Art

[0002] RF electronics, such as cell phones, smart phones, tablets, computers, modems and other devices operate on a limited frequency spectrum. Various schemes are implemented to permit multiple devices to be transmitting and receiving on a particular frequency bands simultaneously. One such scheme is called carrier or channel aggregation which is currently used in 4G LTE Advanced implementations. In this scheme, wider transmission bandwidths are used to simultaneously transmit aggregated component carriers where the component carriers have different frequencies. The component carriers can either be contiguous or non-contiguous frequencies. When multiple component carriers in different bands are aggregated and transmitted, they must be received using multiple bandpass filters, one for each band received. Such filters may be entirely independent from one another, or, coupled together at a common input point, such as at a common antenna. Within the wireless receiving device, often the outputs of such filters must be amplified and re-combined onto a single path. An example of where this is done in a wireless device is the "diversity" receiver.

[0003] However, amplification and combining of these types of signals can result in significant noise and gain differences for signals among the different received frequency bands, which can affect overall signal quality. Hence, there is a need for an improved system and method of amplifying aggregated carrier component signals with reduced noise and improved gain characteristics.

Summary

[0003a] According to a first aspect, a device for amplifying aggregate signals is provided, comprising:

at least one filter that receives either an aggregate signal having a plurality of signal components of different frequency bands and separates the aggregate signal into a plurality of sub-signals of different frequency bands onto a plurality of outputs or an non-aggregate signal having a single signal component that is provided to at least one of the plurality of outputs;

a plurality of amplifiers that are connected to the plurality of outputs to receive the plurality of sub-signals from the plurality of different outputs and amplify the plurality of sub-signals; and

a network connected between the plurality of outputs, the network having components selected to terminate at least a portion of the signals on the plurality of outputs that have a frequency outside of the frequency band corresponding to the output the network being switchable between a first configuration where the network components are terminating at least a portion of the signals on the plurality of outputs when an aggregate signal is received and a second configuration where the network components are not terminating at least a portion of the signal on the plurality of outputs when a non-aggregate signal is received.

[0003b] According to a second aspect, a wireless device is provided comprising a receiver that receives wireless signals;

a processor that controls the operation of the wireless device;

at least one filter that receives either an aggregate signal having a plurality of signal components of different frequency bands and separates the aggregate signal into a plurality of sub-signals of different frequency bands onto a plurality of outputs or a non-aggregate signal having a single signal component that is provided to at least one of the plurality of outputs;

a plurality of amplifiers that are connected to the plurality of outputs to receive the plurality of sub-signals from the plurality of different outputs and amplify the plurality of sub-signals; and

a network connected between the plurality of outputs, the network having components selected to terminate at least a portion of the signals on the plurality of outputs that have a frequency outside of the frequency band corresponding to the output the network being switchable between a first configuration where the network components are terminating at least a portion of the signals on the plurality of outputs when an aggregate signal is received and a second configuration where the network components are not terminating at least a portion of the signal on the plurality of outputs when a non-aggregate signal is received.

[0003c] According to a third aspect, a method of amplifying aggregate signals, comprising:

receiving either aggregate signals having a plurality of signal components having different frequency bands or non-aggregate signals having a single signal component

separating onto outputs aggregate signals having a plurality of signal components of different frequency bands into sub-signals of pre-selected frequency bands;

amplifying the sub-signals; and

selectively interconnecting the outputs via an impedance network, the impedance network being selected so as to at least partially terminate portions of a sub-signal on an output having a frequency other than the pre-selected frequency band when an aggregate signal is received; and

disconnecting the outputs via the impedance network when a non-aggregate signals is received.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Figure 1 is a schematic diagram of a wireless device having a receiver having a filtering component of the present disclosure.

[0005] Figure 2 is a schematic block diagram of an example wireless or network device that can include one or more of the modules of Figure 1.

~~WHAT IS CLAIMED IS:~~

1. A device for amplifying aggregate signals comprising:

at least one filter that receives an aggregate signal comprised of a plurality of signal components having different frequency bands and separates the aggregate signal into a plurality of sub-signals of different frequency bands onto a plurality of outputs;

a plurality of amplifiers that receive the plurality of sub-signals from the plurality of different outputs and amplifies the plurality of sub-signals; and

a network interposed between the plurality of outputs, the network having components selected to terminate at least a portion of the signals on the plurality of outputs that have a frequency outside of the frequency band corresponding to the output.

2. The device of Claim 1, wherein the filter comprises a surface acoustic wave (SAW) filter.

3. The device of Claim 2, wherein the surface acoustic wave (SAW) filter receive a diplex signal and outputs two signals onto two outputs that have different frequencies.

4. The device of Claim 2, wherein the at least one filter comprises a plurality of filters.

5. The device of Claim 1, wherein the plurality of amplifiers comprise low noise amplifiers formed of field effect transistors or bipolar junction transistors.

6. The device of Claim 1, further comprising summing component that sums the amplified sub-signals.

7. The device of Claim 6, wherein the summing component comprises a common node that receives the amplified sub-signals.

8. The device of Claim 1, wherein the network comprises a passive network.

9. The device of Claim 8, wherein the passive network comprises a resistor in parallel with an inductor.

10. The device of Claim 8, wherein the network comprises at least one switch so that the passive network is selectively coupled between the plurality of outputs when sub-signals are being provided to the plurality of outputs and is selectively disengaged when only a single output signal is being provided to one of the plurality of outputs.

11. The device of Claim 10, wherein the at least one switch comprises a plurality of switches that are respectively coupled to the plurality of outputs.

12. A wireless device comprising:

a receiver that receives wireless signals;

a processor that controls the operation of the wireless device;

at least one filter that receives an aggregate signal comprised of a plurality of signal components having different frequency bands and separates the aggregate signal into a plurality of sub-signals of different frequency bands onto a plurality of outputs;

a plurality of amplifiers that receive the plurality of sub-signals from the plurality of different outputs and amplifier the plurality of sub-signals; and

a network interposed between the plurality of outputs, the network having components selected to terminate at least a portion of the signals on the plurality of outputs that have a frequency outside of the frequency band corresponding to the output.

13. The device of Claim 12, wherein the filter comprises a surface acoustic wave (SAW) filter.

14. The device of Claim 13, wherein the surface acoustic wave (SAW) filter receive a diplex signal and outputs two signals onto two outputs that have different frequencies.

15. The device of Claim 12, wherein the at least one filter comprises a plurality of filters.

16. The device of Claim 12, wherein the plurality of amplifiers comprise low noise amplifiers formed of field effect transistors or bipolar junction transistors.

17. The device of Claim 12, further comprising summing component that sums the amplified sub-signals.

18. The device of Claim 17, wherein the summing component comprises a common node that receives the amplified sub-signals.

19. The device of Claim 12, wherein the network comprises a passive network.

20. The device of Claim 19, wherein the passive network comprises a resistor in parallel with an inductor.

21. The device of Claim 19, wherein the network comprises at least one switch so that the passive network is selectively coupled between the plurality of outputs when sub-signals are being provided to the plurality of outputs and is selectively disengaged when only a single output signal is being provided to one of the plurality of outputs.

22. The device of Claim 22, wherein the at least one switch comprises a plurality of switches that are respectively coupled to the plurality of outputs.

23. The device of Claim 12, wherein the device comprises a plurality of filters that receive aggregate signals.

24. A method of amplifying aggregate signals comprising:

separating the aggregate signals having a plurality of signal components having different frequency bands into sub-signals of pre-selected frequency bands onto outputs;

amplifying the sub-signals;

interconnecting the outputs via an impedance network, the impedance network being selected so as to at least partially terminate portions of a sub-signal on an output having a frequency other than the pre-selected frequency band.

25. The method of Claim 24, wherein separating the aggregate signals comprises separating the signals using a multiplex surface acoustic wave (SAW) filter.

26. The method of Claim 24, wherein amplifying the sub-signals comprises amplifying the sub-signals using a low noise amplifier.

27. The method of Claim 24, wherein interconnecting the outputs via an impedance networks comprises interconnecting the outputs via switches and a passive network.

28. The method of Claim 27, wherein the passive network comprises a resistor in parallel with an inductor.

29. The method of Claim 24, further comprising summing the amplified sub-signals.

30. The method of Claim 24, wherein separating the aggregate signals comprising separating the signals using a plurality of filters to produce a plurality of sub-signals.

WHAT IS CLAIMED IS:

1. A device for amplifying aggregate signals comprising:

at least one filter that receives either an aggregate signal having a plurality of signal components of different frequency bands and separates the aggregate signal into a plurality of sub-signals of different frequency bands onto a plurality of outputs or an non-aggregate signal having a single signal component that is provided to at least one of the plurality of outputs;

a plurality of amplifiers that are connected to the plurality of outputs to receive the plurality of sub-signals from the plurality of different outputs and amplify the plurality of sub-signals; and

a network connected between the plurality of outputs, the network having components selected to terminate at least a portion of the signals on the plurality of outputs that have a frequency outside of the frequency band corresponding to the output the network being switchable between a first configuration where the network components are terminating at least a portion of the signals on the plurality of outputs when an aggregate signal is received and a second configuration where the network components are not terminating at least a portion of the signal on the plurality of outputs when a non-aggregate signal is received.

2. The device of claim 1 wherein the filter includes a surface acoustic wave (SAW) filter.

3. The device of claim 2 wherein the surface acoustic wave (SAW) filter receives a diplex signal and outputs two signals onto two outputs that have different frequencies.

4. The device of claim 2 wherein the at least one filter includes a plurality of filters.

5. The device of claim 1 wherein the plurality of amplifiers include low noise amplifiers formed of field effect transistors or bipolar junction transistors.

6. The device of claim 1 further comprising a summing component that sums the amplified sub-signals.

7. The device of claim 6 wherein the summing component includes a common node that receives the amplified sub-signals.

8. The device of claim 1 wherein the network includes a passive network.

9. The device of claim 8 wherein the passive network includes a resistor in parallel with an inductor.

10. The device of claim 8 wherein the network includes at least one switch so that the passive network is selectively coupled between the plurality of outputs when sub-signals are being provided to the plurality of outputs and is selectively disengaged when only a single output signal is being provided to one of the plurality of outputs.

11. The device of claim 10 wherein the at least one switch includes a plurality of switches that are respectively coupled to the plurality of outputs.

12. A wireless device comprising:

a receiver that receives wireless signals;

a processor that controls the operation of the wireless device;

at least one filter that receives either an aggregate signal having a plurality of signal components of different frequency bands and separates the aggregate signal into a plurality of sub-signals of different frequency bands onto a plurality of outputs or a non-aggregate signal having a single signal component that is provided to at least one of the plurality of outputs;

a plurality of amplifiers that are connected to the plurality of outputs to receive the plurality of sub-signals from the plurality of different outputs and amplify the plurality of sub-signals; and

a network connected between the plurality of outputs, the network having components selected to terminate at least a portion of the signals on the plurality of outputs that have a frequency outside of the frequency band corresponding to the output the network being switchable between a first configuration where the network components are terminating at least a portion of the signals on the plurality of outputs when an aggregate signal is received and a second configuration where the network components are not terminating at least a portion of the signal on the plurality of outputs when a non-aggregate signal is received.

13. The device of claim 12 wherein the filter includes a surface acoustic wave (SAW) filter.

14. The device of claim 13 wherein the surface acoustic wave (SAW) filter receives a diplex signal and outputs two signals onto two outputs that have different frequencies.

15. The device of claim 12 wherein the at least one filter includes a plurality of filters.

16. The device of claim 12 wherein the plurality of amplifiers include low noise amplifiers formed of field effect transistors or bipolar junction transistors.

17. The device of claim 12 further comprising a summing component that sums the amplified sub-signals.

18. The device of claim 17 wherein the summing component includes a common node that receives the amplified sub-signals.

19. The device of claim 12 wherein the network includes a passive network.

20. The device of claim 19 wherein the passive network includes a resistor in parallel with an inductor.

21. The device of claim 19 wherein the network includes at least one switch so that the passive network is selectively coupled between the plurality of outputs when sub-signals are being provided to the plurality of outputs and is selectively disengaged when only a single output signal is being provided to one of the plurality of outputs.

22. The device of claim 21 wherein the at least one switch includes a plurality of switches that are respectively coupled to the plurality of outputs.

23. The device of claim 12 wherein the device includes a plurality of filters that receive aggregate signals.

24. A method of amplifying aggregate signals comprising:

receiving either aggregate signals having a plurality of signal components having different frequency bands or non-aggregate signals having a single signal component

separating onto outputs aggregate signals having a plurality of signal components of different frequency bands into sub-signals of pre-selected frequency bands;

amplifying the sub-signals; and

selectively interconnecting the outputs via an impedance network, the impedance network being selected so as to at least partially terminate portions of a sub-signal on an output having a frequency other than the pre-selected frequency band when an aggregate signal is received; and

disconnecting the outputs via the impedance network when a non-aggregate signals is received.

25. The method of claim 24 wherein separating the aggregate signals includes separating the signals using a multiplex surface acoustic wave (SAW) filter.

26. The method of claim 24 wherein amplifying the sub-signals includes amplifying the sub-signals using a low noise amplifier.

27. The method of claim 24 wherein interconnecting the outputs via an impedance networks includes interconnecting the outputs via switches and a passive network.

28. The method of claim 27 wherein the passive network includes a resistor in parallel with an inductor.

29. The method of claim 24 further comprising summing the amplified sub-signals.

30. The method of claim 24 wherein separating the aggregate signals includes separating the signals using a plurality of filters to produce a plurality of sub-signals.