CARRIER AGGREGATION WITH INTEGRATED FILTERS

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims priority to U.S. Provisional Application No. 63/216,388 filed June 29, 2021, entitled CARRIER AGGREGATION WITH INTEGRATED FILTERS, the disclosure of which is hereby expressly incorporated by reference herein in its respective entirety.

BACKGROUND

Field

[0002] The present disclosure relates to carrier aggregation of radio-frequency signals.

Description of the Related Art

[0003] In many communication systems and devices, carrier aggregation of signals in different band can be utilized to accommodate growing band coverage, need for increased throughput, etc. In such systems and devices, complexity of radio-frequency (RF) front-end designs can increase significantly.

SUMMARY

[0003a] In an aspect, the present disclosure refers to a front-end system comprising:

a switch network that includes an antenna node, a first signal node connectable to a first filter-based assembly for a first band, a second signal node connectable to a second filter-based assembly for a second band, and a third signal node connectable to a third filter-based assembly for a third band, the switch network configured to support carrier aggregation of at least the first and second bands;

a reconfigurable routing circuit configured to allow carrier aggregation of the third band and a selected one of the first and second bands utilizing the third filter-based assembly and the filter-based assembly associated with the selected one of the first and second bands; and

a multiplexer that includes a first filter configured to support either or both of the first and second bands, and a second filter configured to support the third band, such that a common node of the multiplexer is coupled to the third signal node of the switch network, a node associated with the first filter is coupled to the reconfigurable routing circuit, and a node associated with the second filter is coupled to the third filter-based assembly, the reconfigurable routing circuit including a switch between the node associated with the first filter of the multiplexer and the signal node associated with the selected one of the first and second bands, each of the first and second band being part of a mid-band having a frequency range of 1695-2200MHz, and the third band being part of a high-band having a frequency range of 2300-2690MHz.

[0003b] In an aspect, the present disclosure refers to a packaged module comprising:

a packaging substrate; and

a front-end system implemented on the packaging substrate and including a switch network that includes an antenna node, a first signal node connectable to a first filter-based assembly for a first band, a second signal node connectable to a second filter-based assembly for a second band, and a third signal node connectable to a third filter-based assembly for a third band, the switch network configured to support carrier aggregation of at least the first and second bands, the front-end system further including a reconfigurable routing circuit configured to allow carrier aggregation of the third band and a selected one of the first and second bands utilizing the third filter-based assembly and the filter-based assembly associated with the selected one of the first and second bands, the front-end system further comprising a multiplexer that includes a first filter configured to support either or both of the first and second bands, and a second filter configured to support the third band, such that a common node of the multiplexer is coupled to the third signal node of the switch network, a node associated with the first filter is coupled to the reconfigurable routing circuit, and a node associated with the second filter is coupled to the third filter-based assembly, the reconfigurable routing circuit including a switch

between the node associated with the first filter of the multiplexer and the signal node associated with the selected one of the first and second bands, each of the first and second band being part of a mid-band having a frequency range of 1695-2200MHz, and the third band being part of a high-band having a frequency range of 2300-2690MHz.

[0003c] In an aspect, the present disclosure refers to a wireless device comprising:

a radio-frequency integrated circuit for processing signals;

an antenna; and

a front-end system implemented to be electrically between the radio-frequency integrated circuit and the antenna, the front-end system including a switch network that includes an antenna node, a first signal node connectable to a first filter-based assembly for a first band, a second signal node connectable to a second filter-based assembly for a second band, and a third signal node connectable to a third filter-based assembly for a third band, the switch network configured to support carrier aggregation of at least the first and second bands, the front-end system further including a reconfigurable routing circuit configured to allow carrier aggregation of the third band and a selected one of the first and second bands utilizing the third filter-based assembly and the filter-based assembly associated with the selected one of the first and second bands, the front-end system further comprising a multiplexer that includes a first filter configured to support either or both of the first and second bands, and a second filter configured to support the third band, such that a common node of the multiplexer is coupled to the third signal node of the switch network, a node associated with the first filter is coupled to the reconfigurable routing circuit, and a node associated with the second filter is coupled to the third filter-based assembly, the reconfigurable routing circuit including a switch between the node associated with the first filter of the multiplexer and the signal node associated with the selected one of the first and second bands, each of the first and second band being part of a mid-band having a frequency range of 1695-2200MHz, and the third band being part of a high-band having a frequency range of 2300-2690MHz.

[0004] In accordance with one example, the present disclosure relates to a front-end system that includes a switch network that includes an antenna node, a first signal node connectable to a first filter-based assembly for a first band, a second signal node connectable to a second filter-based assembly for a second band, and a

third signal node connectable to a third filter-based assembly for a third band. The switch network is configured to support carrier aggregation of at least the first and second bands. The front-end system further includes a reconfigurable routing circuit configured to allow carrier aggregation of the third band and a selected one of the first and second bands utilizing the third filter-based assembly and the filter-based assembly associated with the selected one of the first and second bands.

frequency range of 1695-2200MHz, and the third band can have a frequency range below the mid-band.

[0011] In another example, the present disclosure relates to a packaged module that includes a packaging substrate and a front-end system implemented on the packaging substrate. The front-end system includes a switch network that includes an antenna node, a first signal node connectable to a first filter-based assembly for a first band, a second signal node connectable to a second filter-based assembly for a second band, and a third signal node connectable to a third filter-based assembly for a third band. The switch network is configured to support carrier aggregation of at least the first and second bands. The front-end system further includes a reconfigurable routing circuit configured to allow carrier aggregation of the third band and a selected one of the first and second bands utilizing the third filter-based assembly and the filter-based assembly associated with the selected one of the first and second bands.

[0012] In some examples, the packaged module can further include the first filter-based assembly connected to the first signal node, the second filter-based assembly connected to the second node, and the third filter-based assembly connected to the third node. Each of the first and second filter-based assemblies can include a duplexer configured to support duplex operation involving transmit and receive portions of the respective band.

[0013] In some examples, the packaged module can further include a multiplexer that includes a first filter configured to support either or both of the first and second bands, and a second filter configured to support the third band, such that a common node of the multiplexer is coupled to the third signal node of the switch network, a node associated with the first filter is coupled to the reconfigurable routing circuit, and a node associated with the second filter is coupled to the third filter-based assembly.

[0014] In another example, the present disclosure relates to a wireless device that includes a radio-frequency integrated circuit for processing signals, an antenna, and a front-end system implemented to be electrically between the radio-frequency integrated circuit and the antenna. The front-end system includes a switch network that includes an antenna node, a first signal node connectable to a first filter-based assembly for a first band, a second signal node connectable to a second filter-based assembly for a second band, and a third signal node connectable to a third filter-

WHAT IS CLAIMED IS:

1. A front-end system comprising:

a switch network that includes an antenna node, a first signal node connectable to a first filter-based assembly for a first band, a second signal node connectable to a second filter-based assembly for a second band, and a third signal node connectable to a third filter-based assembly for a third band, the switch network configured to support carrier aggregation of at least the first and second bands;

a reconfigurable routing circuit configured to allow carrier aggregation of the third band and a selected one of the first and second bands utilizing the third filter-based assembly and the filter-based assembly associated with the selected one of the first and second bands; and

a multiplexer that includes a first filter configured to support either or both of the first and second bands, and a second filter configured to support the third band, such that a common node of the multiplexer is coupled to the third signal node of the switch network, a node associated with the first filter is coupled to the reconfigurable routing circuit, and a node associated with the second filter is coupled to the third filter-based assembly, the reconfigurable routing circuit including a switch between the node associated with the first filter of the multiplexer and the signal node associated with the selected one of the first and second bands, each of the first and second band being part of a mid-band having a frequency range of 1695-2200MHz, and the third band being part of a high-band having a frequency range of 2300-2690MHz.

2. The front-end system of claim 1 further comprising the first filter-based assembly connected to the first signal node, the second filter-based assembly connected to the second node, and the third filter-based assembly connected to the third node.

3. The front-end system of claim 1 wherein each of the first and second filter-based assemblies includes a duplexer configured to support duplex operation involving transmit and receive portions of the respective band.

4. The front-end system of claim 3 wherein the third filter-based assembly includes a duplexer configured to support duplex operation involving transmit and receive portions of the third band.

5. The front-end system of claim 3 wherein the third filter-based assembly includes a filter configured to support a transmit or receive portion of the third band.

6. The front-end system of claim 5 wherein the filter is configured to support the receive portion of the third band.

7. The front-end system of claim 1 wherein the multiplexer is implemented as a diplexer.

8. The front-end system of claim 1 wherein the selected one of the first and second bands includes either of the first and second bands.

9. The front-end system of claim 1 wherein the selected one of the first and second bands includes the second band.

10. A packaged module comprising:

a packaging substrate; and

a front-end system implemented on the packaging substrate and including a switch network that includes an antenna node, a first signal node connectable to a first filter-based assembly for a first band, a second signal node connectable to a second filter-based assembly for a second band, and a third signal node connectable to a third filter-based assembly for a third band, the switch network configured to support carrier aggregation of at least the first and second bands, the front-end system further including a reconfigurable routing circuit configured to allow carrier aggregation of the third band and a selected one of the first and second bands utilizing the third filter-based assembly and the filter-based assembly associated with the selected one of the first and second bands, the front-end system further comprising a multiplexer that includes a first filter configured to support either or both of the first and second

bands, and a second filter configured to support the third band, such that a common node of the multiplexer is coupled to the third signal node of the switch network, a node associated with the first filter is coupled to the reconfigurable routing circuit, and a node associated with the second filter is coupled to the third filter-based assembly, the reconfigurable routing circuit including a switch between the node associated with the first filter of the multiplexer and the signal node associated with the selected one of the first and second bands, each of the first and second band being part of a mid-band having a frequency range of 1695-2200MHz, and the third band being part of a high-band having a frequency range of 2300-2690MHz.

11. The packaged module of claim 10 further comprising the first filter-based assembly connected to the first signal node, the second filter-based assembly connected to the second node, and the third filter-based assembly connected to the third node.

12. The packaged module of claim 11 wherein each of the first and second filter-based assemblies includes a duplexer configured to support duplex operation involving transmit and receive portions of the respective band.

13. A wireless device comprising:

a radio-frequency integrated circuit for processing signals;

an antenna; and

a front-end system implemented to be electrically between the radio-frequency integrated circuit and the antenna, the front-end system including a switch network that includes an antenna node, a first signal node connectable to a first filter-based assembly for a first band, a second signal node connectable to a second filter-based assembly for a second band, and a third signal node connectable to a third filter-based assembly for a third band, the switch network configured to support carrier aggregation of at least the first and second bands, the front-end system further including a reconfigurable routing circuit configured to allow carrier aggregation of the third band and a selected one of the first and second bands utilizing the third filter-based assembly and the filter-based assembly associated with the selected one of the first and

second bands, the front-end system further comprising a multiplexer that includes a first filter configured to support either or both of the first and second bands, and a second filter configured to support the third band, such that a common node of the multiplexer is coupled to the third signal node of the switch network, a node associated with the first filter is coupled to the reconfigurable routing circuit, and a node associated with the second filter is coupled to the third filter-based assembly, the reconfigurable routing circuit including a switch between the node associated with the first filter of the multiplexer and the signal node associated with the selected one of the first and second bands, each of the first and second band being part of a mid-band having a frequency range of 1695-2200MHz, and the third band being part of a high-band having a frequency range of 2300-2690MHz.