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

[0004] In accordance with one aspect, 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.

[0005] In some examples, the front-end system 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.

[0006] In some examples, at least a portion of the reconfigurable routing circuit can be part of the switch network.

[0007] In some examples, 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. The third filter-based assembly can include a duplexer configured to support duplex operation involving transmit and receive portions of the third band. The third filter-based assembly can include a filter configured to support a transmit or receive portion of the third band. The filter can be configured to support the receive portion of the third band.

[0008] In some examples, the front-end system 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. In some examples, the multiplexer can be implemented as a diplexer. In some examples, each of the first and second band can be part of a mid-band having a frequency range of 1695-2200MHz, and the third band can be part of a high-band having a frequency range of 2300-2690MHz.

[0009] In some examples, the reconfigurable routing circuit can include 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. The selected one of the first and second bands can include either of the first and second bands. The selected one of the first and second bands can include the second band.

[0010] In some examples, each of the first and second band can be part of a mid-band having a frequency range of 1695-2200MHz, and the third band can be part of a high-band having a frequency range of 2300-2690MHz. In some examples, each of the first and second band can be part of a mid-band having a

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

[0011] In another aspect, 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 aspect, 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-

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.

[0015] For purposes of summarizing the disclosure, certain examples, advantages and novel features of the disclosures have been described herein. It is to be understood that not necessarily all such advantages may be achieved in accordance with any particular example of the disclosure. Thus, the disclosure may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other advantages as may be taught or suggested herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Figure 1 depicts a front-end system having one or more features as described herein, including a feature where an integrated filter associated with one carrier aggregation (CA) mode can be reused for another carrier aggregation mode.

[0017] Figure 2 shows that in some embodiments, the front-end system of Figure 1 can be implemented in a wireless system.

[0018] Figure 3 shows an example of a front-end system configured to support carrier aggregation of two bands.

[0019] Figure 4 shows an example of a front-end system configured to support carrier aggregation of two bands (Band A and Band B) similar to the example of Figure 3, plus carrier aggregation of Band B and a third band (Band C).

[0020] Figure 5 shows an example of a front-end system that can be a more specific example of the front-end system of Figure 1.

[0021] Figure 6 shows a front-end system that can be a more specific example of the front-end system of Figure 5.

[0022] Figure 7 shows the front-end system of Figure 6 configured to provide a carrier aggregation operation involving example bands B3 and B32.

[0023] Figure 8 shows the front-end system of Figure 6 configured to provide a carrier aggregation operation involving example bands B3 and B7.