Claims

1. A filter bank module comprising:
    - a substrate;
    - an antenna port terminal; and
    - a first filter bank die fixed to the substrate, the filter bank die comprising:
        - a first acoustic wave (AW) filter having a first antenna terminal coupled to the antenna port terminal and a first filter terminal, wherein the first AW filter is configured to pass a first passband and attenuate frequencies outside the first passband; and
        - a second AW filter having a second filter terminal, and a second antenna terminal coupled to the first antenna terminal to effectively diplex signals that pass through the first AW filter and the second AW filter, wherein the second AW filter is configured to pass a second passband that is spaced from the first passband to minimize interference between first bandpass and the second bandpass while attenuating frequencies outside the second passband.

2. The filter bank module of claim 1 further comprising:
    - a second filter bank die fixed to the substrate, the filter bank die comprising:
        - a third AW filter having a third antenna terminal coupled to the antenna port terminal and a third filter terminal, wherein the third AW filter is configured to pass a third passband and attenuate frequencies outside the third passband; and
        - a fourth AW filter having a fourth filter terminal, and a fourth antenna terminal coupled to the third antenna terminal to effectively diplex signals that pass through the third AW filter and the fourth AW filter, wherein the fourth AW filter is configured to pass a fourth passband and attenuate frequencies outside the fourth passband.

3. The filter bank module of claim 1 or 2 wherein the first passband is a Unlicensed National Information Infrastructure bands 1 to 2a (UNII-1 to UNII-2a) passband with a filter skirt having a falling slope that spans a gap between adjacent passbands.

4. The filter bank module of any one of claims 1 to 3 wherein the second passband is a UNII-2c to UNII-3 passband with a filter skirt having a rising slope that spans a gap between adjacent passbands.

5. The filter bank module of claim 2 wherein the third passband is a UNII-2c to UNII-4 passband with a filter skirt having a rising slope that spans a gap between adjacent passbands.

6. The filter bank module of claim 2 wherein the fourth passband is a UNII-5 to UNII-8 passband.

7. The filter bank module of claim 2 wherein the first antenna terminal and the second antenna terminal are directly coupled together and the third antenna terminal and the fourth antenna terminal are directly coupled together.

8. The filter bank module of any one of claims 1 to 7 further comprising a single-pole double-throw switch having a first throw terminal coupled to the first filter terminal and a second throw terminal coupled to the second filter terminal and a single pole terminal.

9. The filter bank module of any one of claims 1 to 7 further comprising a double-pole double-throw switch having a first throw terminal coupled to the first filter terminal and a second throw terminal coupled to the second filter terminal, a transmit pole terminal, and a receive pole terminal.

10. The filter bank module of claim 9 wherein the double-pole double-throw switch is configured to selectively couple the receive pole terminal between the first throw terminal and the second throw terminal.

11. The filter bank module of claim 9 wherein the double-pole double-throw switch is configured to selectively couple the transmit pole terminal between the first throw terminal and the second throw terminal.

12. The filter bank module of claim 9 further comprising a low-noise amplifier (LNA) having an LNA input terminal coupled to the receive pole terminal and an LNA output terminal.

13. The filter bank module of claim 12 further comprising a power amplifier (PA) having a PA output coupled to the transmit pole terminal and a PA input.

14. The filter bank module of any one of claims 1 to 7 further comprising a passive filter having a third antenna terminal coupled to the antenna port terminal and a third filter terminal.

15. The filter bank module of claim 14 wherein the passive filter comprises at least one inductor and at least one capacitor.

16. The filter bank module of claim 14 wherein the third antenna terminal is coupled directly to both the first antenna terminal and the second antenna terminal.

17. The filter bank module of claim 14 further comprising a single-pole double-throw switch having a first throw terminal coupled to the first filter terminal and a second throw terminal coupled to the second filter terminal and a single pole terminal.

18. The filter bank module of claim 14 further comprising a double-pole double-throw switch having a first throw terminal coupled to the first filter terminal and a second throw terminal coupled to the second filter terminal, a transmit pole terminal, and a receive pole terminal.

19. The filter bank module of claim 18 wherein the double-pole double-throw switch is configured to selectively couple the receive pole terminal between the first throw terminal and the second throw terminal.

20. The filter bank module of claim 18 wherein the double-pole double-throw switch is configured to selectively couple the transmit pole terminal between the first throw terminal and the second throw terminal.

21. The filter bank module of claim 18 further comprising a low-noise amplifier (LNA) having an LNA input terminal coupled to the receive pole terminal and an LNA output terminal.

22. The filter bank module of claim 21 further comprising a power amplifier (PA) having a PA output coupled to the transmit pole terminal and a PA input.

23. The filter bank module of claim 18 wherein an insertion loss between either of the transmit pole terminal or the receive pole terminal and the antenna port terminal minus an insertion loss of either the first AW filter or the second AW filter is no greater than 1.2 decibels.

24. The filter bank module of claim 18 wherein a real estate area of the filter bank module is no greater than 2.56 square millimeters.

25. The filter bank module of claim 18 wherein a real estate area of the filter bank module is no greater than 4 square millimeters.

26. A filter bank module comprising:

- a substrate;
- an antenna port terminal; and
- a first filter bank die fixed to the substrate, the first filter bank die comprising:
- a first acoustic wave (AW) filter having a first antenna terminal coupled to the antenna port terminal and a first filter terminal, wherein the first AW filter is configured as a bandpass filter to pass Unlicensed National Information Infrastructure (UNII) bands with a filter skirt having a falling slope that spans up to a 160 MHz gap between adjacent passbands; and
- a second AW filter having a second filter terminal, and a second antenna terminal coupled to the first antenna terminal to effectively diplex signals that pass through the first AW filter and the second AW filter.

27. The filter bank module of claim 26 wherein the first AW filter is configured as a bandpass filter to pass the UNII-1 to UNII-2a passband.

28. The filter bank module of claim 26 wherein the first AW filter is configured as a bandpass filter to pass the UNII-2c to UNII-4 passband.

29. The filter bank module of claim 26, wherein the second AW filter is configured as a bandpass filter to pass UNII bands with a filter skirt having a falling slope that spans up to a 160 MHz gap between adjacent passbands.

30. The filter bank module of claim 29 wherein the second AW filter is configured as a bandpass filter to pass the UNII-2c to UNII-4 passband.

31. The filter bank module of claim 29 wherein the second AW filter is configured as a bandpass filter to pass the UNII-5 to UNII-8 passband while rejecting the UNII-2c to UNII-4 passband.

32. The filter bank module of claim 29 wherein the first AW filter is configured as a passband filter to pass the UNII-1 to UNII-2a and the second AW filter is configured as a bandpass filter to pass UNII-2c to UNII-3 passband with a filter skirt having a rising slope that spans up to a 160 MHz gap between adjacent passbands.

33. The filter bank module of claim 26 further comprising:

- a second filter bank die fixed to the substrate, the second filter bank die comprising:
- a third AW filter having a third antenna terminal coupled to the antenna port terminal and a third filter terminal, wherein the third AW filter is configured to pass a third passband and attenuate frequencies outside the third passband; and
- a fourth AW filter having a fourth filter terminal, and a fourth antenna terminal coupled to the third antenna terminal to effectively diplex signals that pass through the third AW filter and the fourth AW filter, wherein the fourth AW filter is configured to pass a fourth passband and attenuate frequencies outside the fourth passband.

34. The filter bank module of claim 33 wherein the third passband is a UNII-2c to UNII-4 passband with a filter skirt having a rising slope that spans a gap between adjacent passbands.

35. The filter bank module of claim 33 wherein the fourth passband is a UNII-5 to UNII-8 passband.