

CLAIMS

What is claimed is:

1. A multimode antenna structure for transmitting and receiving electromagnetic signals in a communication device, the communication device comprising circuitry for processing signals communicated to and from the multimode antenna structure, the multimode antenna structure comprising:

a plurality of antenna ports for coupling to the circuitry;

a plurality of antenna elements, each operatively coupled to a different one of the antenna ports; and

a plurality of coupling elements for electrically coupling to neighboring antenna elements of the plurality of antenna elements, wherein electrical currents on one antenna element of the plurality of antenna elements flow to the neighboring antenna elements and substantially bypass the plurality of antenna ports coupled to the neighboring antenna elements such that an antenna mode excited by one of the plurality of antenna ports is substantially electrically isolated from a mode excited by another one of the plurality of antenna ports at a given desired signal frequency range, wherein at least one antenna element of the plurality of antenna elements comprises branches of different lengths to create resonance at different frequencies.

2. The multimode antenna structure of claim 1, wherein the antenna mode excited by the one of the plurality of antenna ports is substantially electrically isolated from the mode excited by the other one of the plurality of antenna ports at the given desired signal frequency range without coupling a decoupling network to the plurality of antenna ports.

3. The multimode antenna structure of claim 1, the plurality of antenna elements and the plurality of coupling elements are arranged about a periphery of the multimode antenna structure and form a single radiating structure

4. The multimode antenna structure of claim 1, wherein the plurality of antenna elements are an odd number of antenna elements that are coupled with a common counterpoise.

5. The multimode antenna structure of claim 4, wherein the common counterpoise comprises a hollow conductive cylinder.

6. The multimode antenna structure of claim 1, wherein at least one of the plurality of coupling elements has a tortuous configuration to provide a given electrical length.

7. The multimode antenna structure of claim 1, wherein the multimode antenna structure comprises a flexible printed circuit.

8. The multimode antenna structure of claim 7, wherein the flexible printed circuit is wrapped onto a cylinder and packaged in a cylindrical plastic enclosure.

9. The multimode antenna structure of claim 1, further comprising an inductive trace coupled to at least one antenna element of the plurality of antenna elements at a location spaced apart from a respective antenna port of the plurality of antenna ports.

10. The multimode antenna structure of claim 1, wherein the multimode antenna comprises a metal substrate comprising a plurality of coplanar tabs, each connected to a respective antenna element of the plurality of antenna elements, the plurality of coplanar tabs being configured to be secured to an edge of a printed circuit board assembly.

11. A multimode antenna structure comprising:  
a plurality of antenna ports for coupling to circuitry of a communication device to enable the circuitry to process signals communicated to and from the multimode antenna structure;  
a plurality of antenna elements, each operatively coupled to a different one of the antenna ports;  
a common counterpoise, wherein the plurality of antenna elements are coupled with the common counterpoise; and  
a coupling element electrically coupling the plurality of antenna elements to a common point to form a single radiating structure, wherein electrical currents on one antenna element of the plurality of antenna elements flow to another antenna element of the plurality of antenna elements and substantially bypass an antenna port of the plurality of antenna ports coupled to the another antenna element such that an antenna mode excited by the antenna port of the plurality of antenna ports is substantially electrically isolated from a mode excited by another antenna port of the plurality of antenna ports at a given desired signal frequency range, wherein at least one antenna element of the plurality of antenna elements comprises branches of different lengths.

12. The multimode antenna structure of claim 11, wherein the plurality of antenna elements are arranged around a periphery of the multimode antenna structure, and wherein the antenna mode excited by the antenna port of the plurality of antenna ports is substantially electrically isolated from the mode excited by the other antenna port of the plurality of antenna ports at the given desired signal frequency range without coupling a decoupling network to the plurality of antenna ports.

13. The multimode antenna structure of claim 11, wherein the common counterpoise comprises a hollow conductive cylinder.

14. The multimode antenna structure of claim 11, further comprising an inductive trace coupled to at least one antenna element of the plurality of antenna elements at a location spaced apart from a respective antenna port of the plurality of antenna ports.

15. The multimode antenna structure of claim 11, wherein the multimode antenna structure comprises a dielectric substrate, wherein the plurality of antenna elements are disposed on the dielectric substrate.

16. The multimode antenna structure of claim 11, wherein the coupling element has a spoke-like shape.

17. An antenna comprising:  
a plurality of antenna ports for coupling to circuitry of a communication device to enable the circuitry to process signals communicated to and from the antenna;  
a plurality of antenna elements, each operatively coupled to a different one of the plurality of antenna ports, at least one antenna element of the plurality of antenna elements comprising upper and lower planar sections that are spaced apart and a side section coupling the upper and lower sections; and  
one or more coupling elements, each electrically coupling to neighboring antenna elements of the plurality of antenna elements at one of the planar sections such that the plurality of antenna elements form a radiating structure, wherein electrical currents on one antenna element of the plurality of antenna elements flow to a neighboring antenna element of the plurality of antenna elements and substantially bypass one antenna port of the plurality of antenna ports coupled to the neighboring antenna element, wherein the electrical currents flowing through the one antenna element and the neighboring antenna element have a magnitude such that an antenna mode excited by the one antenna port is substantially electrically isolated from a mode excited by another antenna port of the plurality of antenna ports at a given desired signal frequency range, wherein at least one antenna element of the plurality of antenna elements comprises branches of different lengths.

18. The antenna of claim 17, wherein the upper and lower planar sections are substantially parallel, and wherein at least one of the one or more coupling elements has a tortuous configuration to provide a given electrical length.

19. The antenna of claim 17, wherein the antenna mode excited by the one antenna port is substantially electrically isolated from the mode excited by the other antenna port of the plurality of antenna ports at the given desired signal frequency range without coupling a decoupling network to the plurality of antenna ports.

20. The antenna of claim 17, wherein the lower planar section of the at least one antenna element of the plurality of antenna elements is coupled to a printed circuit board assembly.