

CLAIMS

1. A multimode antenna structure for transmitting and receiving electromagnetic signals in a communications device, the communications device including circuitry for processing signals communicated to and from the antenna structure, the 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 connecting elements, each electrically connecting neighboring antenna elements such that the antenna elements and the connecting elements are arranged about the periphery of the antenna structure and form a single radiating structure, wherein electrical currents on one antenna element flow to connected neighboring antenna elements and generally bypass the antenna ports coupled to the neighboring antenna elements such that an antenna mode excited by one antenna port is generally electrically isolated from a mode excited by another antenna port at a given desired signal frequency range, and the antenna structure generates diverse antenna patterns.

2. The multimode antenna structure of claim 1 wherein the plurality of antenna elements comprises three antenna elements and the plurality of connecting elements comprises three connecting elements.

3. The multimode antenna structure of claim 1 wherein the antenna elements are balanced by a common counterpoise.

4. The multimode antenna structure of claim 3 wherein the common counterpoise comprises a hollow conductive cylinder.

5. The multimode antenna structure of claim 4, wherein each of the feed points is coupled to a cable extending through the cylinder.

6. The multimode antenna structure of claim 5 further including a choke comprising a hollow conductive cylinder through which each of the cables pass.

7. The multimode antenna structure of claim 6 wherein each of the cables is a coaxial cable having a cable shield electrically connected to the choke at a common point.

8. The multimode antenna structure of claim 1 wherein each of the plurality of connecting elements has a tortuous configuration to provide a given electrical length.

9. The multimode antenna structure of claim 1 wherein the multimode antenna structure is constructed from a flexible printed circuit.

10. The multimode antenna structure of claim 9 wherein the flexible printed circuit is wrapped onto a cylinder and packaged in a cylindrical plastic enclosure.

11. The multimode antenna structure of claim 1 further comprising an inductive trace coupled to each antenna element at a location on the antenna elements spaced apart from a respective feed point.

12. The multimode antenna structure of claim 1 wherein the antenna structure is formed from a sheet of metal, and includes a plurality of coplanar tabs, each connected to a respective antenna element, the coplanar tabs being configured to be secured to an edge of a printed circuit board assembly.

13. The multimode antenna structure of claim 1 wherein each antenna element has two branches of different lengths to create resonance at two different frequencies.

14. A multimode antenna structure for transmitting and receiving electromagnetic signals in a communications device, the communications device including circuitry for processing signals communicated to and from the antenna structure, the 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, the plurality of antenna elements arranged around the periphery of the antenna structure; and

a connecting element electrically connecting the antenna elements to a common point to form a single radiating structure, wherein electrical currents on one antenna element flow to another antenna element and generally bypass the antenna port coupled to the another antenna element such that an antenna mode excited by one antenna port is generally electrically isolated from a mode excited by another antenna port at a given desired signal frequency range, and the antenna structure generates diverse antenna patterns.

15. The multimode antenna structure of claim 14 wherein the plurality of antenna elements comprises four antenna elements.

16. The multimode antenna structure of claim 14 wherein the antenna elements are balanced by a common counterpoise.

17. The multimode antenna structure of claim 16 wherein the common counterpoise comprises a hollow conductive cylinder.

18. The multimode antenna structure of claim 17 wherein each feed points is coupled to a cable extending through the cylinder.

19. The multimode antenna structure of claim 18 further comprising a choke comprising a hollow conductive cylinder through which each of the cables pass.

20. The multimode antenna structure of claim 19 wherein each of the cables is a coaxial cable having a cable shield electrically connected to the choke at a common point.

21. The multimode antenna structure of claim 14 further comprising an inductive trace coupled to each antenna element at a location on the antenna elements spaced apart from a respective feed point.

22. The multimode antenna structure of claim 14 wherein the antenna structure is formed from a sheet of metal.

23. The multimode antenna structure of claim 14 wherein the monopole antenna elements are constructed from a flexible printed circuit.

24. The multimode antenna structure of claim 23 wherein the connecting element is soldered to the flexible printed circuit.

25. The multimode antenna structure of claim 14 wherein each antenna element has two branches of different lengths to create resonance at two different frequencies.

26. The multimode antenna structure of claim 14 wherein the connecting element has a spoke-like shape.

27. A multimode antenna structure for transmitting and receiving electromagnetic signals in a communications device, the communications device including circuitry for processing signals communicated to and from the antenna structure, the 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, each antenna element including upper and lower planar sections that are generally parallel and spaced apart and a side section connecting the upper and lower sections; and

one or more connecting elements, each electrically connecting neighboring antenna elements at one of the planar sections such that the antenna elements to form a single radiating

structure, wherein electrical currents on one antenna element flow to a connected neighboring antenna element and generally bypass the antenna port coupled to the neighboring antenna element, the electrical currents flowing through the one antenna element and the neighboring antenna element being generally equal in magnitude, such that an antenna mode excited by one antenna port is generally electrically isolated from a mode excited by another antenna port at a given desired signal frequency range, and the antenna structure generates diverse antenna patterns.

28. The multimode antenna structure of claim 27 wherein each of the plurality of connecting elements has a tortuous configuration to provide a given electrical length.

29. The multimode antenna structure of claim 27 wherein each of the plurality of antenna elements has a tortuous configuration to provide a given electrical length.

30. The multimode antenna structure of claim 27 wherein the multimode antenna structure is constructed from a sheet of metal.

31. The multimode antenna structure of claim 27 wherein two connecting elements electrically connect neighboring antenna elements.

32. The multimode antenna structure of claim 27 wherein the lower planar section of each antenna element is connected to a printed circuit board assembly.