

Listing and Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) 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 operatively coupled to the circuitry;

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

one or more connecting elements electrically connecting the antenna elements at a location on each antenna element that is spaced apart from an antenna port coupled thereto to form a single radiating structure and such that 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 ~~elements generate~~ structure generates diverse antenna patterns.

2. (Original) The multimode antenna structure of claim 1 wherein the communications device is a cellular handset, PDA, wireless networking device, or a data card for PC.

3. (Original) The multimode antenna structure of claim 1 wherein the antenna elements comprise dipoles, and the one or more connecting elements connect the dipoles on opposite sides of the antenna ports.

4. (Original) The multimode antenna structure of claim 1 wherein the antenna elements comprise monopoles.

5. (Original) The multimode antenna structure of claim 1 further comprising a matching network to provide an input impedance match for the antenna elements at the desired signal frequency range.

6. (Original) The multimode antenna structure of claim 1 wherein the antenna elements comprise helical coils, wideband planer shapes, chip antennas, meandered shapes, loops, or inductively shunted forms.

7. (Original) The multimode antenna structure of claim 1 wherein at least two of the plurality of antenna elements have different geometrical shapes.

8. (Original) The multimode antenna structure of claim 1 wherein each of the plurality of antenna elements has the same geometrical shape.

9. (Original) The multimode antenna structure of claim 1 wherein each of the plurality of antenna elements is configured to have a given width to provide a desired isolation bandwidth and impedance bandwidth for the antenna structure.

10. (Original) The multimode antenna structure of claim 1 wherein the plurality of antenna elements are spaced apart by a given distance to provide a desired isolation bandwidth and impedance bandwidth for the antenna structure.

11. (Original) The multimode antenna structure of claim 1 wherein the multimode antenna structure comprises a planar structure fabricated on a printed circuit board substrate.

12. (Original) The multimode antenna structure of claim 1 wherein the antenna elements each include split fingers of unequal length to provide multiple resonant frequencies.

13. (Original) The multimode antenna structure of claim 1 wherein the antenna elements are adjustable in length to form a tunable antenna.

14. (Original) The multimode antenna structure of claim 13 wherein the antenna elements each include a controllable switch operable to increase or decrease the effective electrical length of the antenna element.

15. (Original) The multimode antenna structure of claim 1 wherein the one or more connecting elements provide an electrical connection between the antenna elements with an electrical length approximately equal to the electrical distance between the antenna elements.

16. (Original) The multimode antenna structure of claim 1 wherein the one or more connecting elements are configured to have a given electrical length to provide a desired isolation bandwidth for the antenna structure.

17. (Original) The multimode antenna structure of claim 1 wherein the one or more connecting elements are positioned along the lengths of the antenna elements to provide a desired isolation bandwidth for the antenna structure.

18. (Original) The multimode antenna structure of claim 1 wherein the one or more connecting elements comprise a plurality of connecting elements spaced along the lengths of the antenna elements, each of said connecting elements including a switch selectable to open circuit a connection between the connecting element and the antenna elements to provide a desired isolation bandwidth for the antenna structure.

19. (Original) The multimode antenna structure of claim 1 wherein each of the one or more connecting elements includes a filter such that the connecting element provides a connection between antenna elements that is only effective within a given frequency band associated with the filter.

20. (Original) The multimode antenna structure of claim 19 wherein the one or more connecting elements comprise two connecting elements, one of which includes a high pass filter and the other of which includes a low pass filter to provide a dual band antenna structure.

21. (Original) The multimode antenna structure of claim 1 wherein each of the one or more connecting elements includes a tunable element to alter the delay, phase, or impedance of the electrical connection between the antenna elements.

22. (Original) The multimode antenna structure of claim 1 wherein the multimode antenna structure comprises stamped metal part including a pickup feature at the center of mass of the part for use in an automated pick and place assembly process.

23. (Original) The multimode antenna structure of claim 1 wherein the multimode antenna structure comprises a flexible printed circuit mounted on a plastic carrier.

24. (Original) The multimode antenna structure of claim 1 further comprising a sleeve for containing the plurality of antenna elements, and wherein the one or more connecting elements comprises a conductive band in the sleeve that connects neighboring antenna elements.

25. (Original) The multimode antenna structure of claim 24 further comprising coaxial cable connections for connecting the antenna structure to the communications device.

26. (Original) The multimode antenna structure of claim 1 further comprising a plurality of amplifiers, each for amplifying transmit signals applied to one of said antenna ports.

27. (Original) The multimode antenna structure of claim 1 wherein electrical currents on said one antenna element flow to a plurality of connected neighboring antenna elements and generally bypass the antenna ports coupled to the neighboring antenna elements, the electrical currents flowing through the one antenna element and the neighboring antenna elements being generally equal in magnitude.

28. (Currently Amended) A multimode antenna structure for transmitting and receiving electromagnetic signals in a communications device, the communications device including a printed circuit board assembly having circuitry for processing signals communicated to and from the antenna structure, the antenna structure being mounted on a printed circuit board assembly and comprising:

a plurality of antenna ports operatively coupled to the circuitry;

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

one or more connecting elements electrically connecting the antenna elements at a location on each antenna element that is spaced apart from an antenna port coupled thereto to form a single radiating structure and such that 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 ~~elements generate~~ structure generates diverse antenna patterns,

wherein the antenna structure comprises a stamped or printed metal structure.

29. (Original) 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:

at least three antenna ports operatively coupled to the circuitry;

at least three antenna elements, each operatively coupled to a different one of the antenna ports, the antenna elements being positioned in a spaced-apart arrangement about the periphery of an enclosure containing the antenna structure; and

one or more connecting elements electrically connecting each antenna element to a neighboring antenna element such that electrical currents on one antenna element flow to connected neighboring antenna elements and generally bypass the antenna ports coupled to the neighboring antenna elements, the electrical currents flowing through the one antenna element and the neighboring antenna elements 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 elements generate diverse antenna patterns.

30. (New) 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 operatively coupled to the circuitry;

a plurality of antenna elements, each operatively coupled to a different one of the antenna ports, wherein the antenna elements each include split fingers of unequal length to provide multiple resonant frequencies; and

one or more connecting elements electrically connecting the antenna elements such that 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.

31. (New) 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 operatively coupled to the circuitry;

a plurality of antenna elements, each operatively coupled to a different one of the antenna ports, wherein the antenna elements are adjustable in length to form a tunable antenna; and

one or more connecting elements electrically connecting the antenna elements such that 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.

32. (New) The multimode antenna structure of claim 31 wherein the antenna elements each include a controllable switch operable to increase or decrease the effective electrical length of the antenna element.

33. (New) 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 operatively coupled to the circuitry;

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

one or more connecting elements electrically connecting the antenna elements such that 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, wherein the one or more connecting elements comprise a plurality of connecting elements spaced along the lengths of the antenna elements, each of said connecting elements including a switch selectable to open circuit a connection between the connecting element and the antenna elements to provide a desired isolation bandwidth for the antenna structure.

34. (New) 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 operatively coupled to the circuitry;

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

one or more connecting elements electrically connecting the antenna elements such that 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, wherein each of the one or more connecting elements includes a filter such that the connecting element provides a connection between antenna elements that is only effective within a given frequency band associated with the filter.

35. (New) The multimode antenna structure of claim 34 wherein the one or more connecting elements comprise two connecting elements, one of which includes a high pass filter and the other of which includes a low pass filter to provide a dual band antenna structure.

36. (New) 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 operatively coupled to the circuitry;

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

one or more connecting elements electrically connecting the antenna elements such that 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, wherein each of the one or more connecting elements includes a tunable element to alter the delay, phase, or impedance of the electrical connection between the antenna elements.

37. (New) 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 operatively coupled to the circuitry;

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

one or more connecting elements electrically connecting the antenna elements such that 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; and

a sleeve for containing the plurality of antenna elements, wherein the one or more connecting elements comprises a conductive band in the sleeve that connects neighboring antenna elements.

38. (New) The multimode antenna structure of claim 37 further comprising coaxial cable connections for connecting the antenna structure to the communications device.

39. (New) 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 operatively coupled to the circuitry;

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

one or more connecting elements electrically connecting the antenna elements such that 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; and

a plurality of amplifiers, each for amplifying transmit signals applied to one of said antenna ports.