

CLAIMS

1. In a portable electronics device having a printed circuit board assembly, an antenna system comprising:

a first antenna provided on the printed circuit board assembly, said first antenna being fed from a portion of the printed circuit board assembly such that a ground plane of the printed circuit board assembly serves as a counterpoise for the first antenna; and

a second balanced antenna provided on the printed circuit board assembly, said second balanced antenna having dipole ends configured and oriented to generally minimize coupling to the ground plane of the printed circuit board assembly to increase isolation between the first antenna and the second balanced antenna.

2. The antenna system of claim 1 wherein the dipole ends are oriented such that the axis of polarization is generally normal to the ground plane of the printed circuit board assembly.

3. The antenna system of claim 1 wherein the first antenna and the second balanced antenna are provided at opposite ends of the printed circuit board assembly.

4. The antenna system of claim 1 wherein the first antenna and the second balanced antenna are provided at the same end of the printed circuit board assembly.

5. The antenna system of claim 1 wherein the second balanced antenna comprises a conductive foil pattern printed on a carrier attached to the printed circuit board assembly.

6. The antenna system of claim 1 wherein the second balanced antenna comprises a stamped metal part.

7. The antenna system of claim 1 wherein the second balanced antenna comprises two antenna pieces, each attached to an opposite side of the printed circuit board assembly.

8. The antenna system of claim 7 wherein each of the two antenna pieces is soldered to a pad on opposite sides of the printed circuit board assembly, wherein the pads are connected to form an inductive connecting element.

9. The antenna system of claim 1 wherein the second balanced antenna comprises a center fed dipole antenna having capacitive end plates on opposite sides of the printed circuit board assembly, said capacitive end plates being connected by an inductive connecting element.

10. The antenna system of claim 1 wherein the second balanced antenna comprises two generally symmetrical dipole ends positioned generally equidistant from the printed circuit board assembly on opposite sides of the printed circuit board assembly, said dipole ends being excitable to an electrical potential of equal magnitude and opposite sign, resulting in a generally neutral potential at the ground plane.

11. The antenna system of claim 1 wherein the second balanced antenna has a C-shaped cross section, and is disposed around an edge of the printed circuit board assembly.

12. The antenna system of claim 1 wherein said first antenna operates in a WiMAX frequency band and said second balanced antenna operates in a WiFi frequency band.

13. The antenna system of claim 1 wherein the second balanced antenna comprises a plurality of antenna elements, each operatively coupled to a different antenna port, 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.

14. The antenna system of claim 1 further comprising one or more additional antennas attached to an edge of the printed circuit board assembly such that the ground plane of the printed circuit board assembly serves as a counterpoise for the one or more additional antennas.

15. The antenna system of claim 1 wherein the first antenna and the second balanced antenna are in close proximity, and used to achieve reduced SAR values when both antennas are used for simultaneous transmit.

16. An antenna system for a portable electronics device having two or more radios operating independently and simultaneously, the antenna system comprising:

a printed circuit board assembly having a ground plane;

a first antenna provided on the printed circuit board assembly, said first antenna being fed from a portion of the printed circuit board assembly such that the ground plane of the printed circuit board assembly serves as a counterpoise for the first antenna; and

a second balanced antenna comprising two generally symmetrical dipole ends positioned generally equidistant from the printed circuit board assembly on opposite sides of the printed circuit board assembly, said dipole ends being excitable to an electrical potential of equal magnitude and opposite sign, resulting in a generally neutral potential at the ground plane to generally minimize coupling to the ground plane to increase isolation between the first antenna and the second balanced antenna.

17. The antenna system of claim 16 wherein the dipole ends are oriented such that the axis of polarization is generally normal to the ground plane of the printed circuit board assembly.

18. The antenna system of claim 16 wherein the first antenna and the second balanced antenna are provided at opposite ends of the printed circuit board assembly.

19. The antenna system of claim 16 wherein the first antenna and the second balanced antenna are provided at the same end of the printed circuit board assembly.

20. The antenna system of claim 16 wherein the second balanced antenna comprises a conductive foil pattern printed on a carrier attached to the printed circuit board assembly.

21. The antenna system of claim 16 wherein the second balanced antenna comprises a stamped metal part.

22. The antenna system of claim 16 wherein the second balanced antenna comprises two antenna pieces, each attached to a pad on an opposite side of the printed circuit board assembly, wherein the pads are connected to form an inductive connecting element.

23. The antenna system of claim 16 wherein the second balanced antenna has a C-shaped cross section, and is disposed around an edge of the printed circuit board assembly.

24. The antenna system of claim 16 wherein said first antenna operates in a WiMAX frequency band and said second balanced antenna operates in a WiFi frequency band.

25. The antenna system of claim 16 wherein the second balanced antenna comprises a plurality of antenna elements, each operatively coupled to a different antenna port, 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.

26. The antenna system of claim 16 further comprising one or more additional antennas attached to an edge of the printed circuit board assembly such that the ground

plane of the printed circuit board assembly serves as a counterpoise for the one or more additional antennas.

27. The antenna system of claim 16 wherein the first antenna and the second balanced antenna are in close proximity, and used to achieve reduced SAR values when both antennas are used for simultaneous transmit.