CLAIMS

1. A wireless charging device adapted for transmitting radio frequency signals for charging a device to be charged, the wireless charging device comprising a transmitter coupled to at least one transmitting antenna and operable to cause the at least one transmitting antenna to emit electromagnetic radiation; a conductive structure adapted to confine the electromagnetic radiation to a charging zone; and a detector for detecting a degree of impedance mismatch between the transmitter and the at least one transmitting antenna.

2. A wireless charging device according to claim 1, wherein the conductive structure is a radio frequency shielded structure within which the at least one transmitting antenna is located, the charging zone being located within an internal volume of the radiofrequency shielded structure.

3. A wireless charging device according to claim 1, wherein the conductive structure defines a partially enclosed volume within which the at least one transmitting antenna is located and which has an open region allowing for introduction of a device to be charged into the partially enclosed volume, the charging volume occupying at least part of the partially enclosed volume.

4. A wireless charging device according to claim 1, wherein the conductive structure is a planar structure on which the at least one transmitting antenna is located, whereby the charging zone occupies a volume surrounding the at least one transmitting antenna.

5. A wireless charging device according to claim 1, wherein the at least one antenna comprises an array of antennae, each of which may be selected for emitting electromagnetic radiation to modify the charging zone.

6. A wireless charging device according to any of the preceding claims, wherein the at least one antenna is an adaptive impedance transmitting antenna, the impedance of which is variable to modify the charging zone.

7. A wireless charging device according to any of the preceding claims, wherein the detector monitors incident power transmitted to the at least one transmitting antenna and reflected power received from the at least one transmitting antenna, the ratio of these indicating the impedance mismatch between the transmitter and the at least one transmitting antenna.

8. A wireless charging device according to any of the preceding claims, wherein the wireless charging device further comprises a controller coupled to the detector so as to receive at least one signal indicating the degree of impedance mismatch from the detector.

9. A wireless charging device according to claim 8, wherein the controller is adapted to respond to a reflection coefficient S11 from the degree of impedance mismatch and to cause the device to indicate the absence of a device to be charged in the charging zone if the reflection coefficient S11 rises above a threshold value.

10. A wireless charging device according to claim 8 or claim 9, wherein the controller is adapted to respond to the degree of impedance mismatch falling below a threshold value by varying a transmission frequency at which the transmitter causes the at least one transmitting antenna to emit electromagnetic radiation over a frequency range and measuring the degree of impedance mismatch at a plurality of frequencies across the frequency range.

11. A wireless charging device according to claim 10, wherein the controller is adapted to respond to the degree of impedance mismatch falling below the threshold value at at least some of the plurality of frequencies by causing the device to indicate the presence of a non-chargeable, parasitic load in the charging zone.

12. A wireless charging device according to claim 10 or claim 11, wherein the controller is adapted to respond to the degree of impedance mismatch falling below the threshold at each of a set of the plurality of frequencies in a frequency region narrower than the frequency range by commencing a charging process.

13. A wireless charging device according to claim 12, wherein the controller is further adapted on commencement of the charging process to modify the power level at which the transmitter causes the at least one transmitting antenna to emit electromagnetic radiation whilst monitoring the degree of impedance mismatch to determine the power level at which the degree of impedance mismatch exhibits a peak and then setting the power level to that value.

14. A wireless charging device according to claim 12 or claim 13, wherein the controller is adapted during the charging process to monitor the degree of impedance mismatch and to respond to variations in the degree of impedance mismatch in at least one of the following ways:

a) by varying the power level at which the transmitter causes the at least one transmitting antenna to emit electromagnetic radiation;

b) by varying the frequency at which the transmitter causes the at least one transmitting antenna to emit electromagnetic radiation;

c) by controlling an adaptive impedance matching unit coupled to the transmitter and the transmitting antenna to match the impedance of the transmitter and the transmitting antenna; and

d) by coupling at least one antenna of an antenna array to the transmitter and/or by adapting the impedance of an adaptive impedance antenna coupled to the transmitter.

15. A wireless charging device according to any of claims 10 to 14, wherein the controller is adapted to respond to the degree of impedance mismatch falling below the threshold at each of two sets of the plurality of frequencies, each set being in a frequency region narrower than the frequency range by commencing a multiple device charging process.

16. A wireless charging device according to claim 15, wherein the controller is further adapted on commencement of the charging process to set the frequency at which the transmitter causes the at least one transmitting antenna to emit electromagnetic radiation to a value between frequency values within each set at which the impedance mismatch exhibits a peak.

17. A wireless charging device according to claim 16, wherein the controller is further adapted to respond to changes in impedance mismatch by adjusting the frequency at which the transmitter causes the at least one transmitting antenna to emit electromagnetic radiation to a value closer to one of the two peaks than the other.

18. A wireless charging device adapted for transmitting radio frequency (RF) signals for charging a chargeable unit, the wireless charging device comprising a power transmitter coupled to a transmitting antenna for transmitting RF energy to the chargeable unit, a monitor for monitoring a reflection coefficient S11 of the transmitting antenna, and a controller adapted to respond to the monitored S11 value in at least one of the following ways:

a) by varying the power level at which the power transmitter causes the transmitting antenna to transmit RF energy;

b) by varying the frequency at which the power transmitter causes the transmitting antenna to transmit RF energy;

c) by controlling an adaptive impedance matching unit coupled to the power transmitter and the transmitting antenna to match the impedance of the transmitter and the transmitting antenna; and

d) by coupling at least one antenna of an antenna array to the power transmitter and/or by adapting the impedance of an adaptive impedance antenna coupled to the power transmitter.

19. A receiver adapted for receiving radio frequency (RF) signals for use with a wireless charging device according to any of the preceding claims, the receiver comprising an RF receiving antenna, a power conditioning circuit adapted to receive an electrical signal from the RF receiving antenna and condition the electrical signal into a form suitable for charging or powering a load, and a connector for coupling the power conditioning circuit to the load, in use.

20. A receiver according to claim 19, wherein the power conditioning circuit comprises an impedance matching circuit having only passive electrical components.

21. A receiver according to claim 20, wherein the receiver further comprises a switch for interrupting the reception of the electrical output from the receiving antenna by the power conditioning circuit.

22. A wireless charging system comprising a wireless charging device adapted for transmitting RF signals according to any of claims 1 to 18 and at least one receiver adapted for receiving RF signals from said wireless charging device according to any of claims 19 to 21.

23. A wireless charging system according to claim 22, wherein the charging zone includes a region in which the electromagnetic radiation is concentrated relative to the remainder of the charging zone.

24. A wireless charging system according to claim 22 or claim 23, wherein the controller in the wireless charging device is further adapted to monitor the charging state of a battery in a chargeable unit coupled to the receiver by monitoring changes in the degree of impedance mismatch and to vary the power level and/or frequency at which the transmitter causes the at least one transmitting antenna to emit electromagnetic radiation and/or to control an adaptive impedance matching unit coupled to the transmitter and the transmitting antenna to match the impedance of the transmitter and the transmitting antenna.

25. A wireless charging system according to any of claims 22 to 24, wherein the controller in the wireless charging device is further adapted to decrease the power level at which the transmitter causes the at least one transmitting antenna to emit electromagnetic radiation from a starting value for a predefined period of time before returning the power level to the starting value.

26. A wireless charging system according to claim 25, wherein the controller in the wireless charging device is adapted to determine an insertion loss S21 value by calculating the ratio of the difference in the values of S11 during the predefined period and prior to the predefined period to the value of S11 prior to the predefined period.