Description

Load demodulation technique for communication in an inductive charging system

The invention relates to a method for exchanging data between an electronic device, in particular a hearing instrument, having a rechargeable battery and a charging device (charger) for wirelessly charging the battery. It also relates to an inductive charging system comprising the electronic device and the charger for wirelessly charging the battery.

Generally, a hearing instrument is an electronic device being designed to support the hearing of person wearing it (which person is called the user or wearer of the hearing instrument). In particular, the invention relates to a hearing aid, i.e., a hearing instrument that is specifically configured to at least partially compensate a hearing impairment of a hearing-impaired user. Other types of hearing instruments are designed to support the hearing of normal hearing users, i.e., to improve speech perception in complex acoustic situations. Furthermore, the term hearing instrument, as used herein, may relate to a device for streaming an audio signal such as speech or music, e.g. a headset, headphone, ear buds, etc.

Hearing instruments are most often designed to be worn in or at the ear of the user, e.g., as a Behind-The-Ear (BTE) or In-The-Ear (ITE) instrument. With respect to its internal structure, a hearing instrument normally comprises an (acousto-electric) input transducer, a signal processor and an output transducer. During operation of the hearing instrument, the input transducer captures a sound signal from an environment of the hearing instrument and converts it into an input audio signal (i.e., an electric signal transporting a sound information). In the signal

processor, the captured sound signal (i.e., input audio signal) is processed, in particular amplified dependent on sound frequency, to support the hearing of the user, in particular to compensate a hearing-impairment of the user, to suppress ambient noise, etc. The signal processor outputs a processed audio signal (also called processed sound signal) to the output transducer. Most often, the output transducer is an electro-acoustic transducer (also called “receiver”) that converts the processed sound signal into a processed air-borne sound, which is emitted into the ear canal of the user. Alternatively, the output transducer may be an electro-mechanical transducer that converts the processed sound signal into a structure-borne sound (vibrations) that is transmitted, e.g., to the cranial bone of the user**.** Furthermore, besides classical hearing instruments as described before, there are implanted hearing instruments such as cochlear implants, and hearing instruments the output transducers of which output the processed sound signal by directly stimulating the auditory nerve of the user.

Wireless charging of hearing instruments has been proven viable using near-field magnetic or electromagnetic coupling between transmitter and receiver coils, located in the charger and hearing instruments respectively. To facilitate the charging process, a robust and adaptive communication system is needed to enable reliable execution of the charging process. While there are several techniques to employ, the common approaches may fall short in highly dynamic charging systems such as Magnetic Resonance (MR) charging systems.

Different techniques of communication between the hearing instrument and the charger during charging have been envisaged. i.a.

- Bluetooth Low Energy (BLE) communication,
- Acoustic communication,
- Light communication,
- Near Filed Magnetic Inductance (NFMI) communication, and
- Load modulation communication.

BLE is a mature technology that is used widely in many applications. However, critically, BLE is not ubiquitous in all hearing instruments, and the use of BLE would require an additional dedicated BLE communication system in the charger. Moreover, use of BLE capability during charging would require a drastic change in the hearing instrument behaviour during charging, and may not allow to charge a fully-depleted device.

Basically, all hearing instruments possess the required capabilities for acoustic communication. However, this form of communication would require a drastic change in the hearing instrument behaviour during charging, and may not allow to charge a fully-depleted device. Additional charger hardware would be needed and the communication system could be sensitive to ambient interferences and require additional acoustic shielding.

Light communication requires additional hardware on both the hearing instrument and the charger. As the additional lighting component required on the hearing instrument increases component count and device size, this may not be a feasible solution. Notably, such light communication typically requires line-of-sight, while it may not be feasible to ensure fixated orientation during the charging of customized ITE devices. Similarly, this form of communication would require a drastic change in the hearing instrument behaviour during charging, and may not allow to charge a fully-depleted device.

The frequencies of NFMI communication and MR charging are in close proximity and it is likely there will be co-existent compatibility issues between these two technologies. Moreover, costly NFMI hardware would be needed for the charger. Similarly, this form of communication would require a drastic change in the HA device behaviour during charging, and may not allow to charge a fully-depleted device.

Thus, load modulation is a favourable communication technique as it is easy to realize. Existing charging controllers at the receiving side normally have the capability for performing load modulation. Moreover, during charging, the charging

controller remains operational, allowing charging of fully-depleted devices, unlike all other potential solutions.

However, load modulation communication is not free from disadvantages. Typically, high pulse energy and complicated filter and amplification stages are required which, often, lead to reduced efficiency, reduced spatial freedom for charging and less robust and reliable communication.

It is, thus, an object of the invention to provide robust and reliable communication between an electronic device, in particular a hearing instrument, and a charger that can be wirelessly coupled therewith, by virtue of load modulation. In particular, the communication shall be robust and reliable at weak coupling levels, while operating with moderate load modulation pulse energies.

According to the invention, the above object is met by a method with the features of claim 1. It is also met by an inductive charging system having the features of claim 8. Preferred embodiments of the invention are described in the dependent claims and the subsequent description.

Preferably, the method shall be used in a magnetic resonance (MR) charging system. The hallmarks of MR charging system are: High spatial freedom with operability at near or far distances. Thus, the charging system needs to be able to be tuned to resonance, supported by a communication system with strong tolerance against a wide variation of coupling levels between transmitter and receiver coils. High spatial freedom, and most importantly, communication ability at low couplings, can be achieved by strategic placement of the demodulation unit which, preferably, comprises an envelope detector.

The location of the demodulation unit (in particular, the envelope detector) makes a critical impact to the communication system. Known systems place current detectors at the DC stage, or low voltage side, which is easy to implement but makes the communication system susceptible to externally induced noises and inoperable at low coupling levels. The amplitude signals may suffer from poor

signal-to-noise ratios and require large amplification or experience reduced duty ratio. In contrast, as an embodiment of the invention, Fig. 4 shows that the envelope detector is located optimally next to the transmitter coil. Fig. 5 schematically shows a preferred embodiment of the envelope detector, made up of electronic components (e.g. R11, R10, D1, C9 and R9).

In the MR charging system, the transmitter coil is excited with a high frequency source of, e.g., at a frequency of 13.56 MHz. Using the subsequent equation of $I_{tx,max}$, with knowledge of the capacitors' impedances and the measured value of the voltage V_{in}, the current through the transmitter coil can be adequately approximated. Under the resonance operating condition, the resonance current flowing through the transmitter coil, and containing the load modulation data, $I_{tx,max}$, is resonantly amplified.

$$I_{tx,max} = \frac{V_{in,max}}{Z_{C_{17}//C_{22}}}$$

On the receiving side, the load modulation signals are pulsed or periodically loaded by the receiver or charging controller, e.g. at approximately 500 Hz. In the preferred embodiment, the envelope detector circuitry (denoted as "Detector" in Fig. 5), extracts the amplitude data of the high frequency voltage signal of the capacitors (see, for instance, capacitors C17 and C22 in Fig. 5) and calculates the transmitter coil current, using the knowledge of these capacitors' impedances. The carrier or excitation signal is removed.

Then, preferably, the DC component of the amplitude envelope signal is removed, e.g. using a high pass filter (denoted as "HPF" in Fig. 5). Preferably, the thus filtered signal is amplified (e.g. by a factor of 10), e.g. using an active amplifier (denoted as "Amplifier" in Fig. 5; a Bode plot of an exemplary embodiment of the amplifier is depicted in Fig. 6.).

Considering the wide varying spectrum of the coupling levels, it is possible that the amplitude of the high logic at lower coupling levels may intersect with the amplitude of the low logic at higher coupling levels. Therefore, it is not feasible to implement a static comparator for the MR charging system. According to an embodiment of the invention, an average of the amplified signal is obtained (e.g. via an analogue integrator circuit), in order to establish a better working baseline reference voltage for comparison. This averaged signal is used as reference input for the comparator to produce the required load demodulated signal for the microcontroller.

With a system as described above (and an example of which is shown in Fig. 4), a robust implementation of foreign object detection can be implemented. If a foreign (metallic) object is placed within the magnetic or electromagnetic charging field, there will be a change in the envelop detector output, while the remaining demodulation circuits' output remains null, due to the absence of load modulation capability of the foreign object. Thus, even in presence of a foreign object in the charging field, the power fed to the transmitter coil can be properly controlled.

Last but not least, the robust operating capability of the proposed load demodulation circuit allows the resonance operation to enable the high spatial freedom capability and operate at low coupling levels. Most importantly, reliable charging operation can be ensured in either strong or loose coupling situations.

A particular embodiment of the present invention relates to the charger of the inductive charging system according to the invention, without and independent of the electronic device to be charged and the features related thereto. Thus, independent protection is sought for a charger for wirelessly charging an electronic device, in particular a hearing instrument, having a rechargeable battery, which charger comprises an RF circuit operable to produce a radio frequency signal, a transmitter coil being connected to the RF circuit to be fed with said radio frequency signal to make the transmitter coil produce a magnetic or electromagnetic charging field, and a load demodulating circuit operable to demodulate a load modulation signal, which load modulation signal is created in

the electronic device to be charged by modulating said load modulation signal onto a charging current of a receiver coil, and transferred to the charger via magnetic or electromagnetic coupling of the receiver coil and the transmitter coil. In the inventive charger, the load demodulation circuit is connected to the transmitter coil to demodulate the load modulation signal from the radio frequency signal that is fed to the transmitter coil.

Any embodiment or variation of the inductive charging system according to the invention corresponds to an embodiment or variation of the inventive charger, if applicable.

Subsequently, embodiments of the present invention will be described with reference to the accompanying drawings in which

Fig. 1 is a schematic block diagram showing a known inductive charging system comprising an electronic device, in particular a hearing instrument, and a charger which is wirelessly coupled to the hearing instrument for charging a rechargeable battery of the electronic device, in which a charge control unit of the electronic device communicates with the charger by load modulation,

Fig. 2 is a schematic block diagram showing a different known inductive charging system comprising an electronic device, in particular a hearing instrument, and a charger which is wirelessly coupled to the hearing instrument for charging a rechargeable battery of the electronic device, in which a charge control unit of the electronic device communicates with the charger by load modulation,

Fig. 3 is a schematic block diagram showing an embodiment of an inventive inductive charging system comprising an electronic device, in particular a hearing instrument, and a charger which is wirelessly coupled to the hearing instrument for charging a rechargeable battery

of the electronic device, in which a charge control unit of the electronic device communicates with the charger by load modulation,

Fig. 4 is a schematic block diagram showing an embodiment of a load demodulation circuit of the inventive inductive charging system, which load demodulation circuit is implemented in the charger, e.g. the charger of Fig. 3,

Fig. 5 is a circuit diagram showing an exemplary embodiment of the load demodulation circuit of Fig. 4,

Fig. 6 is a Bode plot of an exemplary embodiment of an amplifier of the load demodulation circuit according to Fig. 4 and/or 5, and

Fig. 7 are four synchronous diagrams showing measured characteristics of the inductive charging system of Fig. 5 over time: (1) DC rail voltage signal, resembling the actual load modulation of the input voltage of charging controller (first diagram from top / yellow) (2) amplitude envelope output signal of envelope detector (second diagram from top / green); (3) amplifier output signal, DC and AC-carrier filtered and amplified by a factor of 10 (third diagram from top / blue); (4) load demodulated signal from the comparator output, with averaged input signal as reference input (fourth diagram from top / red).

Like reference numerals indicate like parts, structures and elements unless otherwise indicated.

Fig. 1 shows a known inductive charging system 2'. The system 2' comprises an electronic device which, in the shown example, is a hearing instrument 4, e.g. a BTE or ITE hearing aid provided and designed to support the hearing of a hearing-impaired user.

The system 2 further comprises a charging device (charger 6) that can be wirelessly coupled to the hearing instrument 4 in order to charge a battery (not shown) of the hearing instrument 4.

As parts of the charger 6 and implemented therein, the system 2' comprises

- a DC power supply 8, e.g. a USB port providing, during charging, a DC input voltage of 5 V,
- a current sensor 10, being a part of a load demodulation circuit 11,
- a DC/DC converter 12, i.e. a boost converter converting the DC input voltage provided by the DC power supply 8 into a stepped-up voltage,
- an H bridge 14 converting and amplifying the stepped-up voltage into a radio frequency (RF) signal, and
- a transmitter coil (TX coil) 16, to which the radio frequency (RF) signal is applied and which emits a magnetic or electromagnetic (charging) field.

Thus, the DC power supply 8, the current sensor 10, the DC/DC converter 12, the H bridge 14 and the TX coil 16 form a transmitter circuit 18 which is arranged in the charger 6.

As parts of the hearing instrument 4 and implemented therein, the system 2' comprises

- a receiver coil (RX coil) 20, that generates a charging current when immersed in the magnetic or electromagnetic (charging) field, which charging current is rectified and fed to the battery of the hearing instrument 4, and
- a charging controller 22 that analyses the charging current to be fed to the battery.

Thus, the RX coil 20 and the charging controller 22 form a receiver circuit 24 that is arranged in the hearing instrument 4.

In order to communicate with the charger 6 and, thus, control the charging process, the charging controller 22 modulates a load modulation signal onto the charging current (by amplitude modulation of the charging current). The load modulation signal is re-fed (i.e. transmitted in opposite direction to the power), via the magnetic or electromagnetic coupling of the RX coil 20 and the TX coil 16 to the transmitter circuit 18.

The current sensor 10, being connected between the DC power supply 8 and the DC/DC converter 12, reads out the load modulation signal. A charging controller (not shown) of the charger 6 controls the power of the RF signal and, thus, the power transmitted by magnetic or electromagnetic charging field, in order to adapt the transmitted power to the needs of the hearing instrument 4.

The magnetic or electromagnetic charging field is created with a frequency that matches a resonance frequency of the receiving circuit 24. The inductive charging system 2', thus, is a MR resonance charging system as mentioned above.

As, in the system 2' according to fig. 1 the load demodulation takes place at the DC stage, between the 5V USB power supply 8 and DC/DC converter 12, the load modulation communication is likely to malfunction, if the coupling is reduced. This is because the demodulation circuit will lose signal integrity and lose communication, when the load modulation signal is weakened by the reduced coupling. Moreover, the load demodulation circuitry, when placed at the DC stage, makes itself susceptible to the input voltage quality. For instance, voltage ripples introduced by an external US adapter can disrupt the load demodulation process, and result in disturbance of the charging process.

In Fig. 2, another known inductive charging system 2'' is shown. The system 2'' of Fig. 2 is distinguished from the system 2' of Fig. 1 in that the current sensor 10 is connected to the low voltage side of the H bridge 14, more precisely to the source of one of the low voltage side MOSFETs of H-Bridge 14. Due to the operating principle of the H-Bridge inverter, the current (with the load modulation signal) will flow through the current sensor at 50% duty ratio only, reducing the amount of

signal that can be retrieved. In the system 2'' of fig. 2, similar to the one of fig. 1, the load modulation communication is likely to malfunction, if the coupling is reduced. Reduced coupling levels will cause the demodulation circuit to lose signal integrity and lose communication, when the received load demodulation signal is weakened by the reduced coupling.

Fig. 3 shows an embodiment of an inductive charging system 2 according to the present invention. Unless indicated otherwise, the system 2 of Fig. 3 corresponds to the system 2' of Fig. 1. However, different from the latter, the load demodulation circuit 11 of the system 2 of Fig. 3 is arranged in the RF part of the transmitter circuit 18. In particular, the load demodulation circuit 11 is connected directly (without interposed amplification or frequency conversion) to the Tx coil 16 (referred to as "antenna" in Figs. 4 and 5). However, a matching circuit may be interposed between the Tx coil 16 and the load demodulation circuit 11. In the preferred embodiment, a sensing unit of the load demodulation circuit 11 is connected to the Tx coil 16 (optionally via a matching circuit). Preferably, said sensing unit is formed by an envelope detector 30, that detects an envelope of the RF signal fed to the Tx 16.

Instead of the H bridge 14 of the systems 2', 2'' of Figs. 1 and 2, respectively, the system 2 of Fig. 3 includes a unit for creation and amplification a RF signal, which unit is subsequently referred to as RF circuit 32. In practice, the RF circuit 32 may be formed by an RF oscillator, followed by a driving circuit and an RF amplifier. Preferably, the RF amplifier is a Class E amplifier.

Different from the systems 2', 2'' of Figs. 1 and 2, respectively, the DC-DC converter 12 of the system 2 of Fig. 3 is preferably designed as a buck converter.

In Fig. 4, a preferred embodiment of the load demodulation circuit 11 of the system 2 of Fig. 3 is shown in more detail. As can be seen from the figure, the load demodulation circuit 11 of Fig. 4, in addition to the envelope detector 30, comprises

- a high pass filter 40, being connected upstream of the envelope detector 30
- an amplifier 42, being connected upstream of the high pass filter 40,
- an integrator 44, receiving as input the output of the amplifier 42,
- a comparator 46, receiving as inputs the output of the amplifier 42 and the output of the integrator 44; and
- a microcontroller 48 being the charging controller of the charger 6 or a part thereof.

The high pass filter 40 receives from the envelope detector 30 an amplitude envelope signal corresponding to the amplitude envelope of the RF signal fed to the Tx coil 16. The high pass filter 40 removes a DC component of said amplitude envelope signal. The thus filtered signal is amplified by the amplifier 42 (e.g. by a factor of 10). Preferably, the amplifier 42 has characteristic as is depicted in a Bode plot shown in Fig. 6.

An average of the amplified signal is determined by the integrator 44. This averaged signal is used as reference input for the comparator 46 to produce the required load demodulated signal for the microcontroller 48 which drives the charger so to provide adequate power to the receiver circuit 24. In detail, the microcontroller 48 decodes the data sent by the charging controller 22 of the hearing instrument 4 via load modulation. The microcontroller 48 then analyses this data and decides whether to increase or decrease the power delivered by the charger 6 and controls the DC/DC converter 12 so to adjust its output voltage accordingly.

A circuitry representing a preferred realisation of the load demodulation circuit 11 is shown in Fig. 5.

Measured signals for this embodiment are shown in Fig. 7.

Embodiments of the invention, i.a., have the following beneficial effects:

1) Highly flexible MR charging possible: In the MR charging system, preferably used according to this invention, the load demodulation circuit does not require any fixated impedance phase. This basically allows the charging system to operate at resonance to further improve the charging performances such as high overall efficiency and/or improved spatial freedom during charging. Notably, the inventive load demodulation circuit is robust enough to allow communication even with large variation of coupling levels, not restricting its transmitter and receiver coil placements, unlike known solutions.

2) Superior signal-to-noise ratio: The strategic location of the load modulation data sampling, suggested by the present invention provides significant performance advantage in terms of superior signal-to-noise ratio. According to the invention, the load modulation data is sampled within the resonance circuit. This ensures a clean and amplified load modulation signal as resonance circuits are known to amplify and filter effectively at resonance frequency. Moreover, the signal is free from high frequencies switching noises.

3) Robust against external noises: In a preferred embodiment of the present invention, preferably, a Class E amplifier (which operation is based on resonance principles) is used. Thus, the required input DC voltage range may be below an input voltage of 5V, allowing the use of buck converter which is more robust in view of external noises than other DC-DC converter topologies. Known inductive charging system, typically, use Class D amplifiers (H bridges) that require a higher input voltage. Therefore, the known systems require boost converters that are more sensitive to external noises.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific examples without departing from the spirit and scope of the invention as broadly described in the claims. The present examples are, therefore, to be considered in all aspects as illustrative and not restrictive. In particular, any of the disclosed embodiments of the invention may be varied by including one or more of the variations disclosed above with reference to another of the disclosed embodiments of the invention.

Thus, the disclosed method embodiment may also be varied by including one or more of the system variations.

List of reference numerals

2,2',2''	system
4	hearing instrument
6	charger
8	power supply
10	current sensor
11	load demodulation circuit
12	DC/DC converter
14	H bridge
16	transmitter coil (TX coil)
18	transmitter circuit
20	receiver coil (RX coil)
22	charging controller
24	receiver circuit
30	envelope detector
32	RF circuit
40	high pass filter
42	amplifier
44	integrator
46	comparator
48	microcontroller

Claims

1. Method for exchanging data between an electronic device (4) having a rechargeable battery, and a charger (6) for wirelessly charging the battery, the method comprising:
   - modulating a load modulation signal onto a charging current created by a receiver coil (20) in the electronic device (4),
   - transferring the load modulation signal from the electronic device (4) to the charger (6) via magnetic or electromagnetic coupling of the receiver coil (20) and a transmitter coil (16) of the charger (6),
   - demodulating the load modulation signal in the charger (6),

   wherein the load modulation signal is demodulated from a radio frequency signal that is fed to the transmitter coil (16).

2. Method according to claim 1,
   wherein said radio frequency signal is neither amplified nor frequency converted between demodulation of said load modulation signal and being fed to the transmitter coil (16).

3. Method according to claim 1 or 2,
   wherein the load modulation signal is demodulated from said radio frequency signal by
   - detecting an amplitude envelope of said radio frequency signal to produce an amplitude envelope signal,
   - high-pass-filtering said amplitude envelope signal to produce a filtered signal,
   - amplifying said filtered signal to produce an amplified signal,
   - determining a demodulated signal by comparing the amplified signal with a reference signal.

4. Method according to claim 3,
   wherein said reference signal is determined by obtaining an average of the amplified signal, in particular by integrating the amplified signal.

5. Method of wirelessly charging an electronic device (4), in particular a hearing instrument, by a charger (6), the method comprising:
   - producing a radio frequency signal in the charger (6) and feeding the latter to a transmitter coil (16) of the charger (6) to make the transmitter coil (6) produce a magnetic or electromagnetic charging field,
   - placing a receiver coil (20) of the electronic device (4) in the magnetic or electromagnetic charging field and producing a charging current in the electronic device (4), using a magnetic or electromagnetic coupling of the receiver coil (20) and the transmitter coil (16),
   - feeding said charging current to a rechargeable battery of the electronic device (4), and
   - exchanging data between the electronic device (4) and the charger (6) for controlling the electric power transmitted from the charger (6) to the electronic device (4) using the method of one of claims 1 to 4.

6. Method according to claim 5,
   wherein the radio frequency signal is produced with a frequency that matches a resonance frequency of the electronic device (4), in particular a resonance frequency of a receiver circuit (24) including the receiver coil (20) and the charging controller (22) of the electronic device (4).

7. Method according to claim 5 or 6,
   wherein the radio frequency signal is amplified prior to demodulation of said load modulation signal using a Class E amplifier.

8. Inductive charging system (2) comprising an electronic device (4), in particular a hearing instrument, having a rechargeable battery, and a charger (6) for wirelessly charging the battery, the system (2) further comprising:
   - an RF circuit (32) being arranged in the charger (6) and operable to produce a radio frequency signal in the charger (6),

- a transmitter coil (16) being arranged in the charger (6) being connected to the RF circuit (32) to be fed with said radio frequency signal to make the transmitter coil (6) produce a magnetic or electromagnetic charging field,
- a receiver coil (20) arranged in the electronic device (4) and operable to produce a charging current for the rechargeable battery when placed in the magnetic or electromagnetic charging field, via a magnetic or electromagnetic coupling of the receiver coil (20) and the transmitter coil (16),
- a charging controller (22) arranged in the electronic device (4) and operable to modulate a load modulation signal onto the charging current produced by the receiver coil (20), and
- a load demodulating circuit (11) operable to demodulate the load modulation signal in the charger (6),

wherein the load demodulation circuit (11) is connected to the transmitter coil (16) to demodulate the load modulation signal from the radio frequency signal that is fed to the transmitter coil (16).

9. Inductive charging system (2) according to claim 8,
wherein said load demodulation circuit (11) is connected to the transmitter coil (16) such that the radio frequency signal is neither amplified nor frequency converted between demodulation of said load modulation signal and being fed to the transmitter coil (16)

10. Inductive charging system (2) according to claim 8 or 9,
the load demodulating circuit (11) comprising
- an envelope detector (30) operable to detect an amplitude envelope of said radio frequency signal to produce an amplitude envelope signal,
- a high-pass-filter (40) operable to high-pass-filter said amplitude envelope signal to produce a filtered signal,
- an amplifier (42) operable to amplify said filtered signal to produce an amplified signal, and
- a comparator (46) operable to determine a demodulated signal by comparing the amplified signal with a reference signal.

11. Inductive charging system (2) according to claim 10,
the load demodulating circuit (11) further comprising an integrator (44) for obtaining said reference signal as an average of the amplified signal, by integrating the amplified signal.

12. Inductive charging system (2) according to one of claims 8 to 11,
wherein the RF circuit (32) is designed to produce said radio frequency signal with a frequency that matches a resonance frequency of the electronic device (4), in particular a resonance frequency of a receiver circuit (24) including the receiver coil (20) and the charging controller (22) of the electronic device (4).

13. Inductive charging system (2) according to one of claims 8 to 12,
wherein the RF circuit (32) comprises a Class E amplifier for amplifying the said radio frequency signal.

14. Charger (6) for the inductive charging system (2) according to any of claims 8 to 13.