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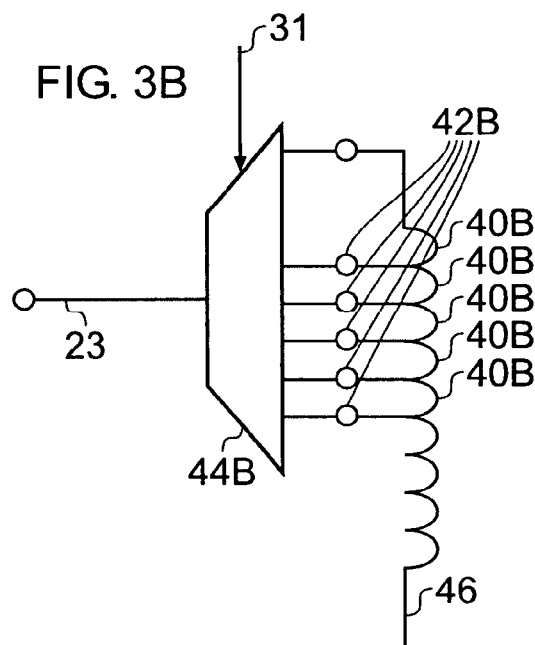
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(54) Title: CONTROLLING THE OUTPUT VOLTAGE OF AN ANTENNA IN A NEAR FILED COMMUNICATION DEVICE



(57) Abstract: A near field communication interface comprising an antenna that operates as a tapped inductor comprising a plurality of taps, an adaptation circuitry configured to adapt the impedance of the antenna by selecting a tap at which the output voltage is a lowest possible value above a threshold value. A method of adapting the antenna of the NFC is also disclosed and consists of measuring the output voltage V_x at a particular tap at which the input impedance of the antenna is X and selecting a tap at which the input impedance is Y such that $V_y = V_x * Y/X$ is the lowest possible value above the threshold value.

TITLE

CONTROLLING THE OUTPUT VOLTAGE OF AN ANTENNA IN A NEAR FIELD
COMMUNICATION
DEVICE

FIELD OF THE INVENTION

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Embodiments of the present invention use electromagnetism for communication and, in particular, near field communication.

BACKGROUND TO THE INVENTION

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Near Field Communications (NFC) is a contactless communications technology. Referring to Fig. 1, an initiator device 2 uses an antenna 4 to generate an electro-magnetic (EM) field. A target device 12 is positioned in the 'near-field' area of the generated EM field and its antenna 14 couples with the generated EM field.

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The target device 12 comprises: the antenna 14, a power recovery circuitry 16 and application circuitry 18.

20 The initiator device 2 and target device 12 operate as an air core transformer and electrical energy is transferred from the initiator device 2 to the power recovery circuitry 16 of target device 12 which uses the transferred power to power the target device 12.

25 Modulation of the EM field by the initiator device 2 results in a modulation of the electric current and voltage induced in the target device, which enables contactless communication from initiator device 2 to the application circuitry 18 of the target device 12. In the illustrated embodiment, the application circuitry is a secure element 18 which hosts one or more secure applications.

30 The secure element may enable the target device 12 to function as a smart card.

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The electrical energy transferred from the initiator device 2 to the target device 12 may be used by the target device 12 to generate an EM field using its antenna 14. The antenna 14 of the target device 12 couples with the antenna 4 of the initiator device 2, which enables contactless communication
5 from target device 12 to initiator device 2

The initiator device 2 may be operating as a reader with the target device operating as, for example, a tag, a secure card or as an emulation of a secure card. The initiator device 2 and the target device 12 may, alternatively, be
10 operating as peer devices in a peer to peer communication network.

BRIEF DESCRIPTION OF VARIOUS EMBODIMENTS OF THE INVENTION

According to various embodiments of the invention there is provided a near
15 field communication interface comprising: an antenna; and adaptation circuitry configured to adapt the antenna in dependence upon an output from the antenna.

The adaptation circuitry adapts the antenna so that the antenna output is
20 better suited to the requirements of the interface. As an example, it may be that the adaptation circuitry adapts the antenna so that the ratio of electric current to voltage at its output is controlled. This may, for example, enable components of the interface to be provided with lower voltages but higher electric currents.

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According to various embodiments of the invention there is provided a method of controlling a near field communication interface comprising: receiving a near field electromagnetic radiation at an antenna; and adapting the antenna in dependence upon an output from the antenna.

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According to various embodiments of the invention there is provided an apparatus comprising: a near field antenna; measurement means for

measuring an electrical parameter from an output of the antenna; and adaptation means for adapting the antenna in dependence upon the measured electrical parameter.

- 5 According to various embodiments of the invention there is provided an antenna arrangement comprising: an antenna comprising a plurality of elements that are interconnectable in different combinations to provide different outputs; circuitry for measuring an electrical parameter of a signal output by the antenna when elements of the antenna are interconnected in a first combination; and circuitry for adapting the antenna to have a second combination of elements that is dependent upon the measured electrical parameter.

- 15 According to various embodiments of the invention there is provided a method comprising: measuring an electrical parameter of a signal output by an antenna that comprises a plurality of elements that are interconnectable in different combinations to provide different outputs, when the elements of the antenna are interconnected in a first combination; and adapting the antenna to have a second combination of elements that is dependent upon the measured electrical parameter.

BRIEF DESCRIPTION OF THE DRAWINGS

- 25 For a better understanding of various embodiments of the present invention reference will now be made by way of example only to the accompanying drawings in which:

Fig. 1 schematically illustrates an initiator device and a target device;

Fig 2 schematically illustrates a near field communication interface;

- 30 Figs 3A and 3B illustrate antennas which comprise a plurality of elements that are interconnectable in different combinations;

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Fig 4 schematically illustrates a loop antenna that comprises a plurality of loops of conductive traces wound around the perimeter of a printed wiring board (PWB); and

Fig. 5 illustrates a state machine for the near field communication interface.

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DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS OF THE INVENTION

Fig 2 schematically illustrates a near field contactless communication interface 20 comprising: an antenna 24; an NFC modem 22 connected to the antenna 24; application circuitry 28 connected to the NFC modem 22; control circuitry 30 connected to the antenna 24 and power recovery circuitry 26 connected to the control circuitry 30, the NFC modem 22, the antenna 24, and the application circuitry 28.

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The antenna 24 operates in a manner similar to the antenna 14 described in relation to Fig 1. It is arranged to couple to a near field electromagnetic field generated by a proximal device. When the interface 20 is communicating with another interface, the antenna 24 operates as a 'winding' of an air core transformer. The antenna 24 provides power to the power recovery circuitry 26 and data to the NFC modem 22. The antenna 24 is dynamically configurable via control signal 31 provided by the control circuitry 30.

The control signal 31 is used to adapt an input impedance of the antenna 24, so that the ratio of voltage and electric current provided as an output signal 23 from the antenna 24 can be controlled. The inductance of the antenna 24 may, in particular, be dynamically controlled.

Typically the control signal 31 is used to adapt a configuration of the antenna 24, for example, as illustrated in Figs 3A and 3B.

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Figs 3A and 3B illustrate antennas 24 each of which comprises a plurality of elements 40 that are interconnectable in different combinations to provide different output signals 23. The components illustrated in Figs 2, 3A and 3B that use the same numerical prefix reference the same or similar components, however, suffixes A and B may also be used respectively in Figs 3A and 3B .

In Fig 3A, the antenna 24A comprises, in series connection, a plurality of elements 40A. A tap 42A may be placed in series connection between two adjacent elements 40A. In the illustrated example, there are N serially connected elements E1, E2, E3... EN and M associated taps T1, T2, T3... TM, where tap Tm is positioned between elements En and En+1. In the illustrated example there is a tap for each element so that N=M but this is not necessarily always the case.

A M:1 multiplexer 44A receives inputs, in parallel, from each of the M taps 42A and the control signal 31 is provided as a selector signal to the multiplexer 44A to select a particular tap 42A to provide the output signal 23 of the antenna 24A.

The elements 40A may be inductive elements in which case the antenna 24A operates as a tapped inductor.

If the antenna 24A has an output voltage $V(x)$ from tap Tx, then if each of the elements 40A have the same impedance, the output voltage $V(y)$ at tap Ty would be $V(x) * y/x$. In the more general case if the impedance values of the elements 40A are known, and the output voltage at one tap T is measured then the voltage output at any other tap can be calculated. Thus a particular tap may be selected for a particular output voltage from the antenna 24A.

In Fig 3B, the antenna 24B comprises a looped or coiled conductor 46 with taps 42B at different points along the length of the conductor. The antenna 24B is electrically analogous to that illustrated in Fig 4A where each element

40A of Fig 3A is a group of coils/loops in Fig 3B. The control signal 31 selects via multiplexer 44B the number of coils/loops used in the present configuration of the antenna 24B to provide an output signal 23.

- 5 The antenna 24A may be a loop antenna that comprises a plurality of loops of conductive traces 49 wound around the perimeter of a printed wiring board (PWB) 48, for example, as illustrated in Fig 4.

Referring back to Fig. 2, the near field communication (NFC) modem 22 is an optional component. The NFC modem 22 enables the interface 20 to operate in dual modes as an initiator device 2 or as a target device 12. If only a single mode interface that operates only as a target device 12, for example, is required then an NFC modem 22 may not be used. NFC currently occurs at 13.56MHz over a distance of less than about 20cm. The NFC modem is connected to the antenna 24 and to the secure element 28 for data communication.

In the illustrated embodiment, the application circuitry is a secure element 18 which hosts one or more secure applications. The secure element may enable the interface 20 to function as a smart card. The secure element 18 may be an integral part of the interface 20 or it may be a detachable module such as a physical smart card, for example, a subscriber identity module (SIM) card or user identity module (UIM) card. As used here 'module' refers to a unit or apparatus that excludes certain parts/components that would be added by an end manufacturer or a user.

The control circuitry 30 controls the configuration of the antenna 24 via the control signal 31.

- 30 The control circuitry may be implemented as a simple state machine 50, for example, as illustrated in Fig. 5.

This illustrative state machine has a 'sleep' state 52, a 'set initial antenna configuration state' state 54, a 'measure antenna parameter' state 56 and an 'adapt antenna configuration' state 58 and an optional 'idle' state 60.

- 5 In the sleep state 52 the control circuitry 30 is using no or little power.

The power recovery circuitry 26 may be connected directly to the antenna 24 so that when the antenna 24 couples with a near field EM field the power recovery circuit 26 is energized and outputs a voltage to at least the control
10 circuitry 30. This output voltage operates as an interrupt for the control circuitry 30, which wakes-up and enters 53 the 'set initial antenna configuration' state 54. In this state, the control circuitry 30 provides a predetermined control signal 31 to antenna 24 so that it adapts to a known initial configuration.

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The state then automatically changes 55 to the 'measure antenna parameter' state 56. In this state, measurement circuitry 32 receives the output signal 23 from antenna 24 while it is in the known configuration. The measurement circuitry 32 measures a parameter of the received output signal 23.

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The state machine 50 then automatically changes 57 to the 'adapt antenna configuration state' 58. In this state, adaptation circuitry 34 in the control circuitry 30 uses the measured parameter and knowledge of the configuration of the antenna 24 to select a new configuration of the antenna 24 that
25 provides via the output signal 23 a desired value of the parameter.

As an example, if the antenna 24 has a plurality of configurations each of which has a different input impedance $Z_1, Z_2 \dots Z(M-1), Z(M) \dots Z(N) \dots$, then the initial configuration of the antenna 24 may be such that the output signal
30 $V(N)$ is taken when the input impedance is $Z(N)$. The adaptation circuitry 34 can change the configuration of the antenna 24 so that the voltage of the output signal 23 is the minimum value above a threshold V_{min} by, for

example, adapting the antenna 24 using the control signal 31 so that the input impedance is $Z(M)$ where $V(N) * Z(M)/Z(N) > V_{min} > V(N) * Z(M-1)/Z(N)$.

5 If the antenna 24 is a coiled antenna, such as that illustrated in Fig 3B, and has N coils. Then the initial configuration of the antenna 24 may be such that the output signal is taken from the N th coil and the measured parameter may be the voltage $V(N)$ at the N th coil. N coils are serially connected to provide the output voltage signal 23. The adaptation circuitry 34 can change the configuration of the antenna 24 so that the voltage of the output signal 23 is
10 the minimum value above a threshold V_{min} by, for example, adapting the antenna 24 using the control signal 31 so that the output signal 23 is taken from the M th coil where $V(N) * M/N > V_{min} > V(N) * (M-1)/N$. In this scenario, the antenna 24 has a configuration in which M coils are serially connected to provide the output voltage signal 23.

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For a regular coiled antenna having N coils of equal area A , the output power P depends on the area A , but not on the number N of turns. The output voltage V is directly proportional to the local magnetic field strength, the area A and the number N of turns. The output current I is given by $P=V.I$.
20 Therefore increasing the number of turns N does not affect power but increases output voltage and decreases output current and decreasing the number of turns N does not affect power but decreases output voltage and increases output current.

25 The control circuitry 30 using control signal 31 optimizes the output 23 of the antenna 24 for voltage and current.

Typically, the adaptation circuitry 34 is configured to adapt the antenna 24 to provide at least a predetermined minimum threshold voltage level while
30 maximizing current i.e. setting the voltage to the minimum value above the threshold. The threshold voltage may, for example, be 1.8V or 2.7V.

In the event that a minimum threshold current cannot be provided, either the power P must be increased by, for example, adapting the area of the antenna 24 or the interface 20 will not function correctly and a warning may be provided to a user or instructions given to bring the initiator and target devices closer together.

After adapting the antenna configuration at state 58, there is an optional transition 59 to the idle state 60. The idle state 60 may be present if, for example, it is desired to repeatedly reconfigure the antenna 24. In this circumstance, an interrupt such as a first timeout, may cause a transition 61 from the idle state 60 to the 'measure antenna parameter' state 56 and a different interrupt such as a longer duration timeout may cause a transition 51 from the idle state 60 to the sleep state 52. The idle state 60 is optional because in alternative embodiments there may be a direct transition from the 'adapt antenna configuration' state 58 to the sleep state 52.

The power recovery circuitry 26 may comprise a diode bridge rectifier. In one embodiment, first power recovery circuitry, such as a diode bridge rectifier, is used to initially provide power to the interface 20 until the antenna configuration has been adapted at the 'adapt antenna configuration' state 58 at which point a second active power recovery circuit is used to provide power to the interface 20. One form of active power recovery circuit uses field effect transistors in a diode bridge rectifier arrangement. The FET may be such that a control signal is be applied to the FET to make it operate as a diode.

The power recovery circuit 26 may receive different output signals from the antenna 24. For example, the power recovery circuit 26 may differentiate between different components of the interface depending upon their electric current requirements and/or voltage requirements. The power recovery circuit 26 may, for example, draw power for components of the interface 20 that require higher voltage/lower current from a tap T_v of the antenna 24 and draw power for components of the interface that require higher current/lower

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voltage from a tap Tc of the antenna 24. A first multiplexer could be used to select the tap Tv and a second multiplexer, arranged in parallel with the first multiplexer, could be used to select the tap Tc.

- 5 Thus the antenna 24 may be simultaneously in two different configurations. One configuration provides higher current to components such as the data processing components (e.g. the NFC modem 22 and the secure element 28) and another configuration provides higher voltage to components such as the antenna control components (e.g. control circuitry 30 and multiplexer 44).

10

The interface 20 may be a module suitable for integration within a device such as a portable personal electronic device 39 which may be, for example, a mobile cellular telephone, a personal music player, an electronic wallet etc.

- 15 The illustrated portable personal electronic device 39 comprises functional circuitry 38 and a portable power source 36.

The functional circuitry 38 enables operation of the device and the performance of its functions. In some embodiments, it may include displays,
20 input devices, processor, memory etc.

The portable power source 36 may be, for example, a battery or a fuel cell.

- 25 In circumstances where there is a local power source 36 from which the interface 20 may draw power, then the configuration of the antenna 24 may not be important and a default configuration may be used. Thus the transition 55 from the 'set initial antenna configuration' 54 to the 'measure antenna parameter' state 56 may be conditional on there being no available local power, for example, because there is no local power source 36 or because
30 the local power source 36 is unavailable because it is exhausted or unavailable because the host device 39 is switched off.

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Although embodiments of the present invention have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the invention as claimed.

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Features described in the preceding description may be used in combinations other than the combinations explicitly described.

10 Whilst endeavoring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

15 I/we claim:

CLAIMS

1. A near field communication interface comprising:
5 an antenna; and
adaptation circuitry configured to adapt the antenna in dependence upon an output from the antenna.
2. An interface as claimed in claim 1, wherein the adaptation circuitry is
10 configured to adapt the antenna input impedance.
3. An interface as claimed in claim 1 or 2, wherein the adaptation circuitry is configured to adapt a configuration of the antenna.
- 15 4. An interface as claimed in any preceding claim, wherein the antenna comprises a plurality of connectable elements and wherein the adaptation circuitry is configured to adapt the number of elements connected.
- 20 5. An interface as claimed in any preceding claim, wherein the antenna operates as a tapped inductor comprising a plurality of taps from which an output may be taken and wherein the adaptation circuitry is configured to select a tap for the antenna output.
- 25 6. An interface as claimed in claim 5, wherein the adaptation circuitry is configured to control a multiplexer which provides the antenna output.
7. An interface as claimed in any preceding claim, wherein the antenna comprises coils and the adaptation circuitry is configured to adapt the number of coils used to provide an output from the antenna.

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8. An interface as claimed in any preceding claim, wherein the measurement circuitry is configured to measure an electrical parameter from an output of the antenna.

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9. An interface as claimed in claim 8, wherein the adaptation circuitry is configured to adapt the antenna in dependence the measured electrical parameter.

10 10. An interface as claimed in claim 8 or 9, wherein the antenna the measured electrical parameter is voltage.

11. An interface as claimed in any one of claims 8 to 10, wherein the antenna operates as a tapped inductor comprising a plurality of taps, the measured
15 electrical parameter is an output voltage V from a particular tap at which the input impedance of the antenna is X , and wherein the adaptation circuitry is configured to adapt the antenna by selecting a tap at which the input impedance is Y such that $Y \cdot V/X$ satisfies a defined constraint.

20 12. An interface as claimed in claim 11, wherein the defined constraint is that $Y \cdot V/X$ is a lowest possible value above a threshold value.

13. An interface as claimed in any preceding claim, wherein the adaptation circuitry is configured to adapt the antenna to provide at least a predetermined
25 threshold voltage level while maximizing current.

14. An interface as claimed in any preceding claim, wherein the adaptation circuitry is configured to adapt the antenna to provide a minimum voltage above a predetermined threshold voltage level.

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15. An interface as claimed in any preceding claim, further comprising power recovery circuitry for obtaining operating power for the interface from the output of the antenna.

5 16. An interface as claimed in claim 15, wherein the antenna has multiple output taps and wherein the power recovery circuitry is configured to use a first tap for providing power for antenna control and a second selected tap for providing power for data processing.

10 17. An interface as claimed in any preceding claim, wherein the adaptation circuitry is configured to adapt the antenna in dependence upon an output from the antenna but only in the absence of a local power source.

15 18. A portable personal electronic device comprising an interface as claimed in any preceding claim.

19. A method of controlling a near field communication interface comprising:
receiving a near field electromagnetic radiation at an antenna; and
adapting the antenna in dependence upon an output from the antenna.

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20. A method as claimed in claim 19, comprising adapting the antenna to provide at least a predetermined threshold voltage level while maximizing current.

25 21. A method as claimed in claim 19, comprising adapting the antenna to provide a minimum voltage above a predetermined threshold voltage level.

22. An apparatus comprising:
a near field antenna;

30 measurement means for measuring an electrical parameter from an output of the antenna; and

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adaptation means for adapting the antenna in dependence upon the measured electrical parameter.

23. An apparatus as claimed in claim 22, wherein the measured electrical
5 parameter is an output voltage V from a first configuration of the antenna at which the input impedance of the antenna is X , and wherein the adaptation means is configured to adapt the antenna to a second configuration at which the input impedance is Y such that $Y \cdot V/X$ satisfies a defined constraint.

10 24. An apparatus as claimed in claim 23, wherein the defined constraint is that $Y \cdot V/X$ is a lowest possible value above a threshold value.

25. An antenna arrangement comprising:
an antenna comprising a plurality of elements that are interconnectable in
15 different combinations to provide different outputs;
circuitry for measuring an electrical parameter of a signal output by the antenna when elements of the antenna are interconnected in a first combination; and
circuitry for adapting the antenna to have a second combination of elements
20 that is dependent upon the measured electrical parameter.

26. A method comprising:
measuring an electrical parameter of a signal output by an antenna that
comprises a plurality of elements that are interconnectable in different
25 combinations to provide different outputs, when the elements of the antenna are interconnected in a first combination; and
adapting the antenna to have a second combination of elements that is dependent upon the measured electrical parameter.

30 27. An apparatus comprising:
an antenna; and

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adaptation circuitry configured to adapt the antenna in dependence upon an output from the antenna.

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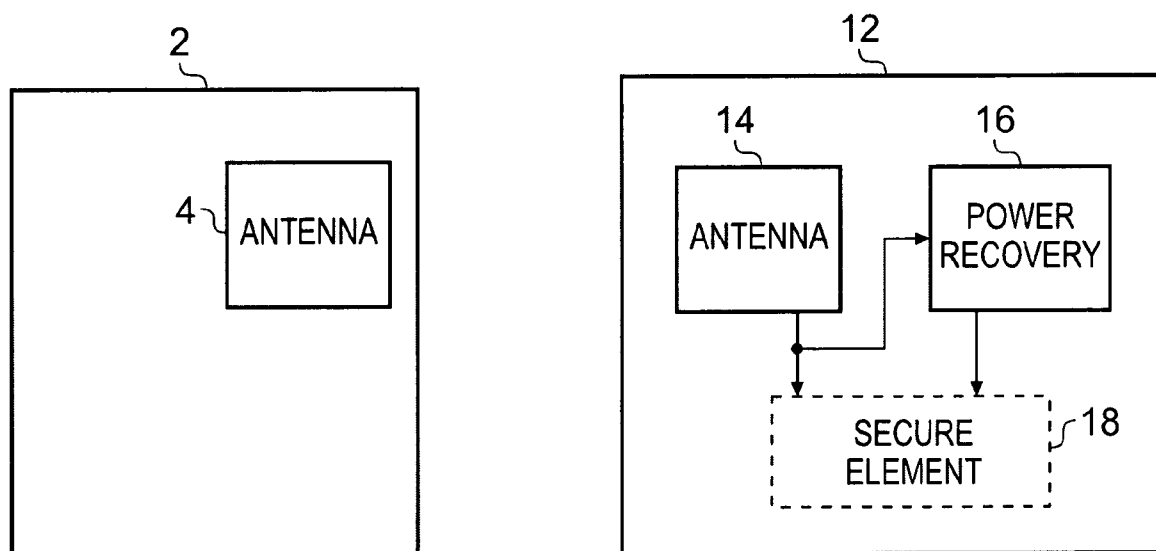


FIG. 1

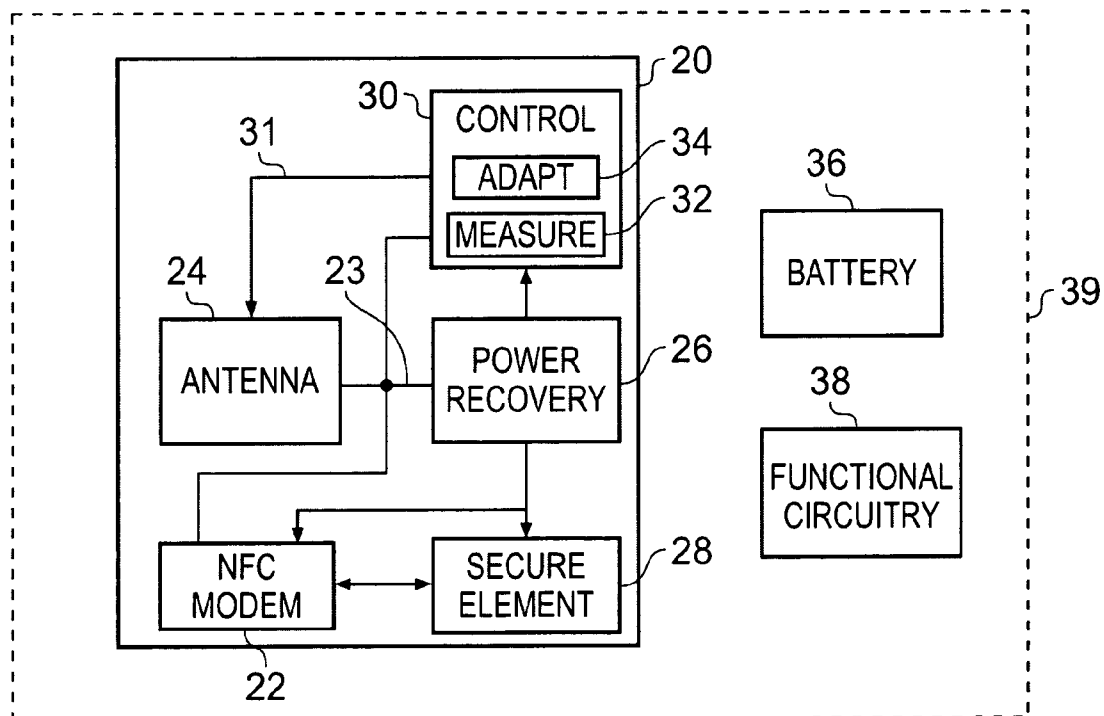


FIG. 2

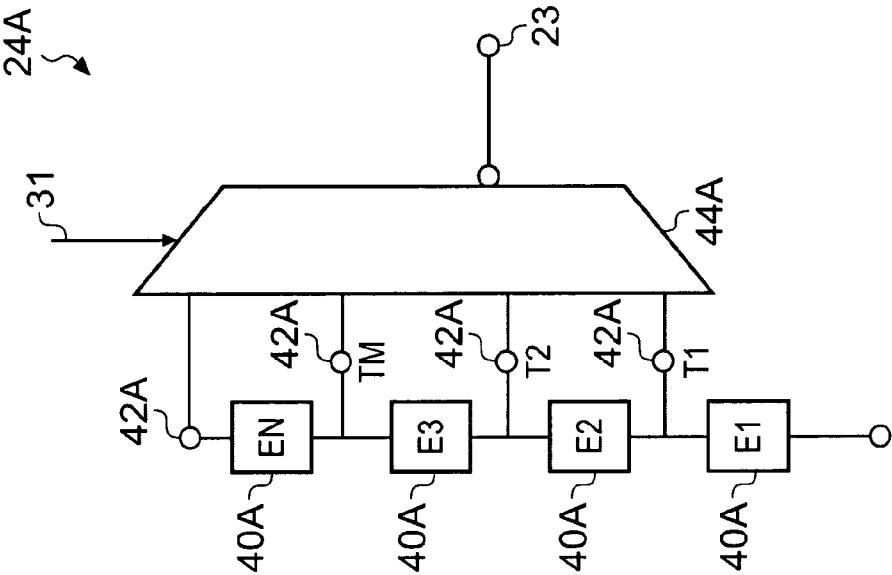


FIG. 3A

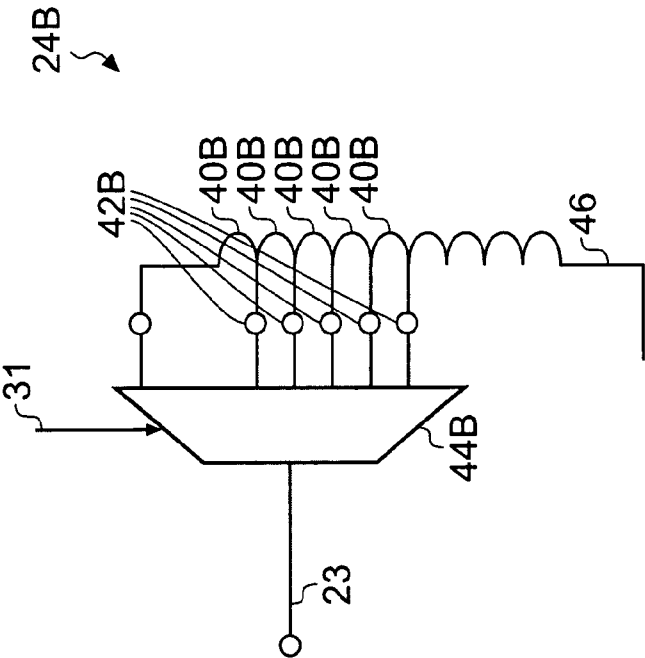


FIG. 3B

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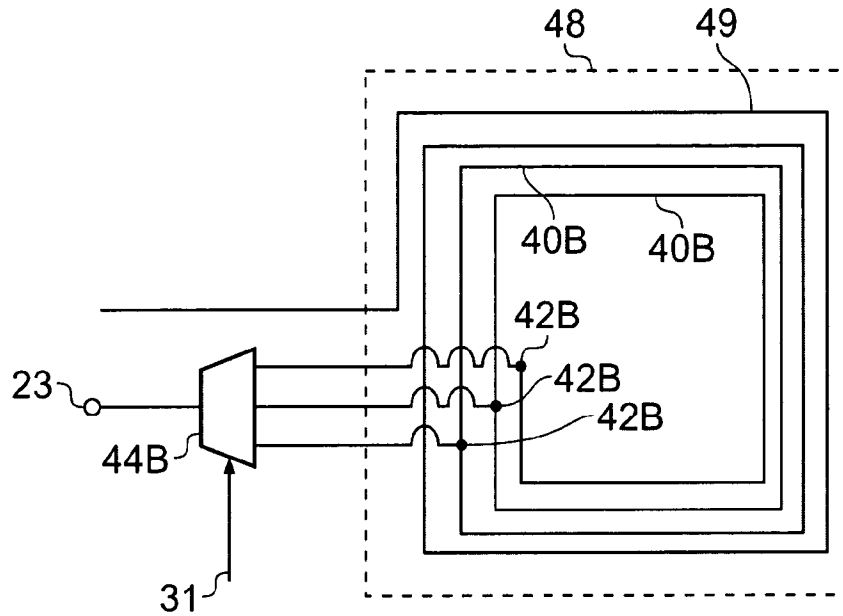


FIG. 4

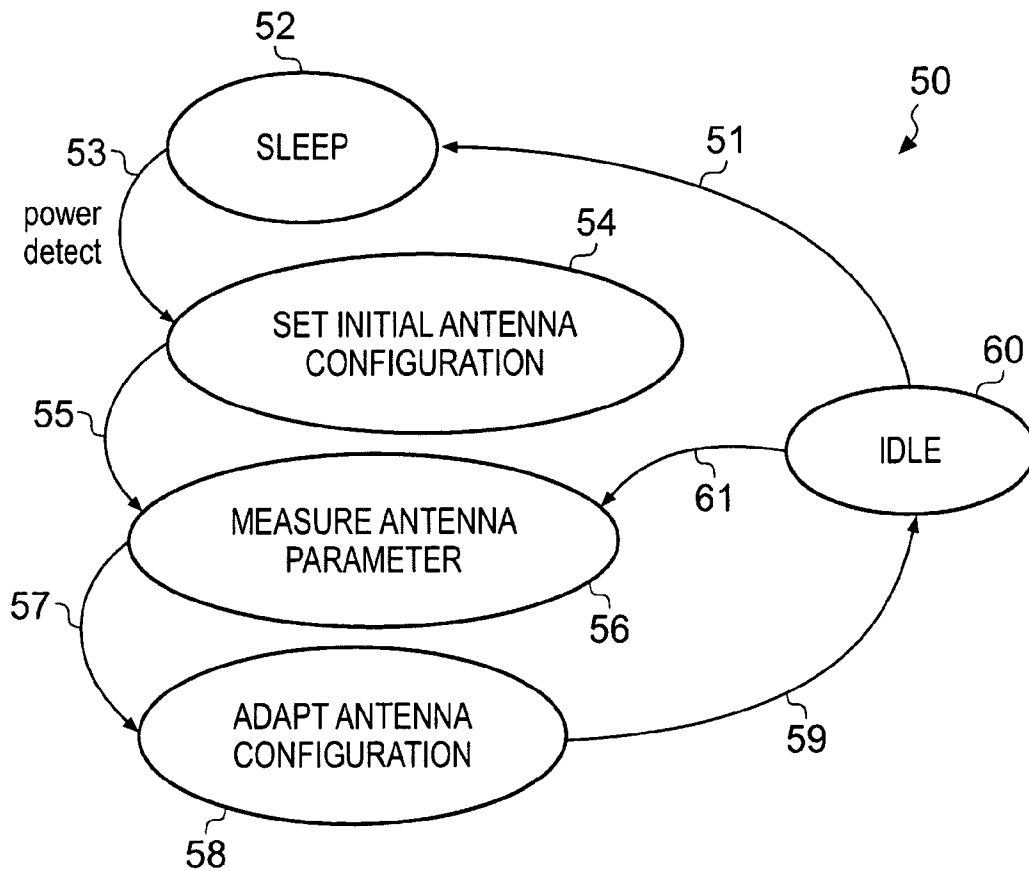


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/053243

A. CLASSIFICATION OF SUBJECT MATTER

INV. G06K19/077 H01Q7/00 H01Q1/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06K H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 061 663 A (MITSUBISHI MATERIALS CORP [JP]) 20 December 2000 (2000-12-20) the whole document	1-27
X	EP 0 829 940 A (HITACHI LTD [JP]) 18 March 1998 (1998-03-18) the whole document	1-27
X	EP 1 160 915 A (MITSUBISHI MATERIALS CORP [JP]) 5 December 2001 (2001-12-05) paragraphs [0006] - [0032], [0041] - [0065]; figures 1-5	1-27
X	WO 89/10030 A (UNISCAN LTD [AU]; MAGELLAN TECH PTY LTD [AU]) 19 October 1989 (1989-10-19) the whole document	1-27
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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/053243

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 03/081802 A (MELEXIS NV [BE]; LEMAN DIRK [BE]) 2 October 2003 (2003-10-02) the whole document -----	1-27

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2008/053243

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
EP 1061663	A	20-12-2000	WO JP	0028674 A1 2000151480 A	18-05-2000 30-05-2000
EP 0829940	A	18-03-1998	CA CN SG US ZA	2215257 A1 1178407 A 54559 A1 6321067 B1 9708188 A	13-03-1998 08-04-1998 16-11-1998 20-11-2001 11-03-1999
EP 1160915	A	05-12-2001	JP US	2001344574 A 2002017980 A1	14-12-2001 14-02-2002
WO 8910030	A	19-10-1989	AT CA DE DE EP JP	115792 T 1338675 C 68920038 D1 68920038 T2 0409880 A1 3505148 T	15-12-1994 22-10-1996 26-01-1995 03-08-1995 30-01-1991 07-11-1991
WO 03081802	A	02-10-2003	AU	2003215791 A1	08-10-2003