A SYSTEM FOR EXCHANGING DATA BY COMMUNICATION VIA CONTACTS OR WITHOUT CONTACT BETWEEN A TERMINAL AND PORTABLE OBJECTS

The invention relates to techniques for contactless communication between a portable object and a terminal.

It is well known to exchange data without contact; applications of this technique include, in non-limiting manner, controlling access, electronic payment ("electronic purse" type applications), and remote payment, e.g. for access to and payment of public transport.

In the latter example, each user is provided with a portable object of the "contactless card" or "contactless badge" type, which object is capable of interchanging information with a "terminal" that is fixed (or possibly moving) by bringing the badge close to the terminal so as to allow them to be coupled together without using a metallic path (the term "terminal" is used in the present description to designate the data transmitter/receiver apparatus suitable for co-operating with the portable objects).

More precisely, this coupling is achieved by varying a magnetic field produced by an induction coil (which technique is known as the "induction method"). To this end, the terminal includes an inductive circuit excited by an alternating signal which produces an alternating magnetic field in the surrounding space. When in this space, the portable object detects the field and in response it modulates the load of the portable object coupled to the terminal; this variation is detected by the terminal, thereby establishing the looked-for both-way communication.

There also exist many terminals that communicate over metallic paths via electrical contacts with existing portable objects, in particular those commonly called "smart cards". For that reason, amongst others, it is advantageous to have portable objects that are capable of

communicating with terminals equally well over a metallic path (via contacts) and over a non-metallic path (without contact).

EP-A-0 424 726 describes such a dual-mode card capable of communicating with or without contact. In that card, communication is established selectively via contact areas or via coils, as a function of the presence of an electric voltage on the contact areas or on the coils.

Nevertheless, a drawback of that system lies in switching as a function of a voltage being present turns out to be difficult to apply in practice. In particular, the appearance of interference can disturb operation. Thus, an interfering decrease in the power supply voltage at the contacts can cause the communication path via the coil to be selected in untimely manner, activating a shunt regulator through which excess current then flows when the regulator is connected across the power supply terminals. That system is also ill-suited to selecting conditions for starting the processor circuit and for running it, since loss of power via a contact will give rise to an interfering restart. Selecting starting as a function of information derived from a comparison between two power supplies presents the difficulty of ensuring, under all conditions of powering up, that the selection is locked at the right moment.

One of the objects of the present invention is to provide another manner of detecting which communication mode to use and of controlling the various functions of the portable object accordingly.

The portable object of the invention is of the same general type as that described in above-mentioned EP-A-0 424 726, i.e. a portable object including a plurality of electrical contacts for communicating over a metallic path with a terminal of a first type, itself including a plurality of corresponding electrical contacts, and also including a coil for contactless

communication with a terminal of a second type that transmits a modulated electromagnetic field to convey data.

The portable object is characterized in that for data transmitted by the terminal and clocked by a clock signal, it includes clock detector means to modify the operation of the portable object as a function of the presence or the absence of a clock signal in the signal received.

Also preferably, the clock detector means detect the clock signal in the signal picked up by the coil.

Preferably, when in contactless communication mode, the portable object is remotely powered by the electromagnetic field received by the coil and the clock signal, in which case it includes rectifier and filter means for obtaining a DC power supply voltage for the object from the electromagnetic field as picked up by the coil while in contactless communication mode, and detector means having input receiving the signal present between the coil and the rectifier and filter means (where the signal is at its greatest amplitude).

The clock signal can be extracted from the same location. In particular, the clock can be defined by the frequency of the received carrier, divided in the clock extractor means.

This makes it possible to detect the presence of the clock signal in a manner that is more sensitive and more reliable. The data itself is preferably extracted downstream from the rectifier and filter stage, such that signal demodulation is more stable, particularly if amplitude modulation is used.

According to various advantageous subsidiary characteristics, the following are provided:

- means for demodulating the signal picked up by the coil, so as to extract communication data therefrom, in particular amplitude demodulator means operating on the

signal delivered at the output of the rectifier and filter stages;

• downstream from the rectifier and filter means, regulator means for stabilizing the DC voltage, together with means for selectively inhibiting the regulator means and under the control of the clock detector means;

• means for transmitting data from the portable object to the terminal in contactless mode by load modulation at the terminals of the coil; advantageously, modulation is then modulation of a subcarrier produced by dividing the frequency of the clock delivered by the detector means and/or the circuit is capable of operating in two different power consumption modes: with nominal power consumption and with low power consumption, and means are provided for putting the circuit into low power consumption mode before the data transmission means begin performing said modulation.

The clock detector means can select protocols for communications and/or signal processing and/or received data processing. Thus, the signal indicating whether a clock is present or absent can be used in various ways, e.g. by supplying the inhibit signal to a regulator which stabilizes the DC power supply voltage, thereby ensuring that the regulator operates only in contactless mode. The risk of activating this shunt regulator at the wrong time is eliminated. Also, the clock presence/absence signal can be used in generating the signal for activating the processor circuit and selecting its clock signal. Finally, the protocols for communications and for processing signals can be different, with modes of communication that differ in being performed with or without contact, and the presence or absence of the clock can serve to control which protocols are used.

Finally, it can be desirable to provide switch means in the links between the electrical contacts and the other circuits of the portable object, the switch means being under the control of the clock detector means so as

to interrupt said links whenever the portable object is communicating over the contactless path. This makes it possible to avoid attempts at fraud involving picking up and deciphering signals which would otherwise appear on the contacts if they were to remain accessible in this mode of communication. It is useful to provide an analog switch to interrupt the link in the mode of communication via contacts in order to avoid interpreting as data any interference that may appear on the unused input (coil or contacts).

In an advantageous embodiment of a portable object that is remotely powered in contactless mode, there is provided, downstream from the rectifier and filter stages, a stabilizer stage including a shunt regulator element mounted in parallel with the circuit to be powered between its power supply terminals and associated with a resistive component connected in series in the power supply line of the circuit, the shunt regulator element diverting a variable fraction of the power supply current of the circuit so that the resistive element and the shunt regulator element dissipate any excess power not required for operation of the circuit, thereby, in corresponding manner, stabilizing the power supply voltage across the terminals of the circuit, limiting the voltage excursion at the terminals of the upstream tuned elements, and preventing variations in current consumption having any influence upstream on the amplitude of the signal to be demodulated.

In particular, means may be provided to selectively and temporarily inhibit operation of the shunt regulator, in particular in response to detecting communication of a type that passes via contacts.

Finally, the electronic circuit of the portable object, with the exception of the coil of the tuned element, is most advantageously implemented in integrated monolithic technology.

◊

There follows a detailed description of an embodiment of the invention given with reference to the accompanying drawings in which the same numerical references designate elements that are identical or functionally similar.

Figure 1 is a block diagram of a system of the invention in its most general aspect, comprising a terminal and a portable object in the field of the terminal.

Figure 2 shows a particular embodiment of the portable object of Figure 1.

Figure 3 shows the regulator circuit of Figure 2 in greater detail.

Figures 4 and 5 show two possible variants of the demodulator circuit of Figure 2 in greater detail.

Figure 6 is a detailed diagram of the Figure 5 demodulator circuit.

Figure 7 shows the clock extractor circuit of Figure 2 in greater detail.

Figure 8 is a set of waveform diagrams showing how the portable object is remotely powered and how the clock signal is extracted.

Figure 9 is a set of waveform diagrams explaining how information is transmitted from the terminal to the object.

Figure 10 is a series of waveform diagrams explaining how information is transmitted from the object to the terminal.

Figure 11 shows the various switching operations performed in a dual-mode card between its two modes of operation: via contacts and contactless.

◊

An embodiment of the system of the invention is described with reference to the diagram of Figure 1. In this diagram, reference 100 designates a terminal which can be coupled to a portable object 200 placed in the vicinity thereof.

The terminal includes a transmitter coil 102 which, in association with a capacitor such as 104, forms a tuned circuit 106 designed to generate a modulated magnetic induction field. The frequency to which the circuit 106 is tuned may be 13.56 MHz, for example, which value is naturally not limiting, this particular choice stemming merely from the fact that it corresponds to a value authorized by European standards for communications functions and for remote powering functions. In addition, this relatively high value makes it possible to design circuits having coils that possess few turns, and that are therefore easy and cheap to implement.

The tuned circuit 106 is powered by a sustained-wave high frequency oscillator 108 and it is modulated by a mixer stage 110 driven by the signals to be transmitted TXD coming from a digital circuit 112. The operation of the circuit 112, and in particular the sequencing of the signals TXD is clocked by a circuit 114 producing a clock signal CLK.

Receiver stages which extract received data RXD from the signal picked up across the terminals of the coil 102 comprise a high frequency demodulator circuit 116 together with a subcarrier demodulator circuit 118 when, in the manner described below, it has been decided to use subcarrier modulation in the direction portable object → terminal (this technique naturally not being limiting in any way, modulation could equally well be performed in baseband).

The portable object 200 includes a coil 202 co-operating with an electronic circuit 204 which, advantageously, is implemented in fully integrated monolithic technology so as to enable the object to be small in size, typically having the format of a "credit card". By way of example, the coil 202 is a printed coil and the set of circuits 204 is implemented in the form of an application specific integrated circuit (ASIC).

The coil 202 co-operates with a capacitor 206 to form a resonant circuit 208 tuned to a given frequency (e.g. 13.56 MHz) enabling data to be interchanged in both directions with the terminal by the so-called "induction" technique and also enabling the object to be remotely powered by the magnetic field picked up by the coil 202, i.e. by the same coil as the coil used for interchanging information.

The alternating voltage a picked up across the terminals of the tuned circuit 208 is applied to a half-wave or a full-wave rectifier stage 210 followed by a filter stage 212 to deliver a filtered rectified voltage b.

The portable object also includes a digital processing stage 214, typically implemented on the basis of a microprocessor, RAM, ROM, and EPROM memories, and interfacing circuits.

Downstream from the rectifier and filtering stages 210 and 212 there are connected in parallel various specific stages comprising:

- A voltage-stabilizing regulator stage 216 delivering at its output a DC voltage d that is rectified, filtered, and stabilized, and that is applied in particular to the positive power supply terminal VCC of the digital circuit 214 whose other power supply terminal is ground GND.
  This stabilizer stage 216 can be a conventional type of voltage stabilizer or, in a non-limiting variant, a specific circuit as described below with reference to Figures 2 and 3.
- A demodulator stage 218 receiving the signal b as its input and delivering at its output a demodulated signal e which is applied to the dat input RXD of the digital circuit 214.
  This demodulator can, in particular, be a demodulator that detects variations in amplitude and/or with a variable threshold, as explained in

greater detail below with reference to Figures 4, 5, and 6.

- A clock extractor stage 220 whose input receives the signal a picked up from the terminals of the tuned circuit 208 and whose output delivers a signal c applied to the clock input CLK of the digital circuit 214.

  The clock extractor stage 220 can be located either upstream from the rectifier and filter stages 210 and 212, as shown, or else downstream from said stages, i.e. it can operate on the signal b instead of the signal a; nevertheless, it is less advantageous to use the signal b insofar as the clock extractor then needs to have greater sensitivity in order to compensate for the smoothing of the signal as performed by the filter stage.

- A modulator stage 222 which operates in conventional manner by "load modulation", a technique which consists in causing the current drawn by the tuned circuit 208 that is situated in the surrounding magnetic field generated by the terminal to vary in controlled manner.

  The modulator circuit 222 comprises a resistive element 224 (a separate resistor component or, in monolithic technology, a MOS type component having no grid and acting as a resistance) connected in series with a switch element 226 (a MOS transistor) controlled by the modulation signal f present on the output TXD of the digital circuit 214. In a variant, instead of being placed downstream from the rectifier and filter circuits 210 and 212, the modulator stage 222 may equally well be placed upstream from said circuits, as shown at 222' in Figure 1, i.e. it may be connected directly to the terminals of the resonant circuit 208.

The general structure proposed in this way and in which the demodulator stage 218 is situated downstream from the rectifier and filter stages 210 and 212, has the advantage of reduced sensitivity to instantaneous variations in the signal.

With a portable object that is remotely powered, performing demodulation on a signal that has been rectified and filtered makes it possible to reduce the effects of instantaneous variations in the power supply during an oscillation cycle.

This aspect will be better understood from the detailed description of the operation of the demodulator given below with reference to the waveform diagrams of Figure 8.

A particular embodiment of the structure shown in Figure 1 is described below with reference to Figure 2, which embodiment is characterized by a particular structure given to the regulator stage 216 which, as explained in greater detail below, is a stage of the "shunt regulator" type having a shunt component 228 serving to divert power supply current in controlled manner away from the digital circuit 214. The shunt component is thus connected in parallel with the circuit 214, between its power supply and ground terminals VCC and GND, and is associated with a series resistive element 230 placed in the power supply line VCC upstream from the regulator component 228.

The shunt 228 may advantageously be a zener diode, or preferably a separate or integrated component that is functionally equivalent to a zener diode, e.g. a component in the LM185/LM285/LM385 family from National Semiconductor Corporation, which component forms a reference voltage (a voltage that is fixed or adjustable depending on the component) while drawing a bias current of only 20 µA, having very low dynamic impedance and an operating current range of 20 µA to 20 mA. The component

228 may also be integrated in the ASIC as a monolithic equivalent of such a voltage reference component.

Figure 3 shows a particular embodiment of this circuit 216 using a component of the type described above with its voltage reference input 234 being biased to a predetermined value by a divider bridge 236, 238 connected between VCC and ground.

The resistive element 230 may be a separate resistor or, advantageously, an integrated monolithic component, e.g. a MOS element acting as a resistance like the component 224.

Advantageously, a switch component such as a MOS transistor 240 is also provided and maintained in the conductive state in normal operation by a signal $\overline{INH}$ being applied to its grid. This transistor can be switched to its non-conductive state by applying a simple control signal INH (specifically under software control from the computing circuit 214) having the effect of inhibiting operation of the shunt regulator, with the circuit then behaving as though the regulator had been omitted.

This ability to inhibit the shunt regulator can be used, in particular, when it is desired to power the microprocessor at a high voltage while avoiding the risk of destroying the regulator stage.

This situation arises in particular for test purposes, or when the portable object is a dual-mode object capable of being used selectively in "contactless" mode (with the regulator in operation) or in "contact" mode (with the regulator inhibited), the regulated power supply voltage then being applied directly to one of the contacts of the portable object without there being any need to perform specific regulation as there is with remote powering.

The amplitude demodulator stage 218 is described below in greater detail with reference to Figures 4 to 6.

The amplitude demodulator is a circuit suitable for processing modulated signals in which the depth of modulation is low. The terms "low depth of modulation" or "low modulation" are used to mean modulation at a ratio that is typically less than or equal to 50%, and preferably less than 20%, with the "ratio" being defined as $(A_{max}-A_{min})/(A_{max}+A_{min})$ of the maximum and minimum amplitudes A_{max} and A_{min} of the signal under consideration.

In the particular context of a remotely powered portable object, it is advantageous, given power supply constraints, to use a low modulation ratio so as to ensure that sufficient power is available during periods when modulation is in the low state, since amplitude modulation has the effect of causing the instantaneous power that is delivered to the portable object to vary directly with modulation level.

Figure 4 shows a first possible variant in which the demodulator is an adaptive demodulator having a variable threshold.

After an optional lowpass filter stage 242, the circuit comprises a comparator 244, preferably having hysteresis, with its positive input receiving the signal b to be demodulated (where appropriate filtered by the stage 242) and with its negative input receiving the same signal b, but after it has passed through an RC stage 246, 248 acting as an integrator. Comparison is thus performed between the instantaneous value of the signal and an averaged value of the signal which constitutes the variable comparison threshold.

Figure 5 shows a second possible variant of the demodulator 218, which in this case is a demodulator that is sensitive to variations of amplitude.

After an optional lowpass filter stage 242, the signal b is applied to a CR stage 250, 252 acting as a differentiator. The signal output thereby is applied to the positive terminal of the comparator 244 (in this case likewise preferably having hysteresis) whose negative

input is connected to a fixed potential, e.g. ground. In this case, the demodulator is responsive to variations in amplitude (because of the differentiator stage), independently of the mean value of the signal; the comparator only detects variations in the mean value.

Figure 6 shows a more detailed embodiment of such a demodulator circuit for detecting variations in amplitude. In addition to the lowpass filter 242 constituted by the resistor 252 and the capacitor 254, there is a series capacitor 250 acting as a differentiator in combination with resistors 256 to 264. The signal differentiated in this way is applied to two symmetrical comparators 244 and 266 whose outputs act on two cross-coupled bistables 268 and 270 organized to produce two appropriately-shaped symmetrical signals RXD and $\overline{RXD}$.

Figure 7 shows an embodiment of the clock detector and extractor circuit 220.

On its input, this circuit receives a signal taken from the terminals of the resonant circuit 208 and it is applied to the differential inputs of a comparator with hysteresis 272 which delivers the clock signal CLK. The clock signal is also applied to the two inputs of an EXCLUSIVE OR gate 274, directly to one of the inputs and via an RC circuit 276, 278 on the other input. The RC circuit applies a delay to the signal as picked up, which delay is chosen to have a time constant of the order of $1/4f_{CLK}$ (where f_{CLK} is the frequency of the clock generated by the circuit 114 of the terminal 100). The output signal from the gate 274 is then averaged by an RC circuit 280, 282 having a time constant that is much greater than $1/2f_{CLK}$ (preferably about $1/f_{CLK}$) and is then applied to one of the inputs of a comparator 284 for comparison with a fixed threshold S.

The clock signal CLK serves to apply appropriate clocking to the digital processor circuit 214, while the

output from the comparator 280 gives a signal PRSCLK indicating whether or not a clock signal is present.

For a dual-mode card suitable for operating equally well in "contactless" mode and in "contact" mode, the signal PRSCLK indicating whether the clock signal is present or absent is advantageously used to inform the digital circuit that the portable object is in a "contactless" type environment and to decide on corresponding actions such as selecting an appropriate communications protocol, and activating the shunt regulator, PRSCLK being used to generate $\overline{INH}$ (see description above with reference to Figure 3), etc.

Figure 11 shows in detail the various switches that are operated automatically in this way between "contactless" mode and "contact" mode. The contacts 286 are as follows: CLK (clock), GND (ground), I/O (data), VCC (power supply), and $\overline{RST}$ (reset to zero), complying with the ISO 7816-3 standard, to which reference can be made for further details. The various switches 288 to 296 are all shown in the "contact" position (referenced "0") which is the default position, and they are changed over to the "contactless" position (referenced "1") under the control of the signal PRSCLK delivered by the circuit 220 and indicating that a clock signal is present coming from the rectifier and filter means.

Extraction of a clock signal is also particularly advantageous when it is desired to perform modulation that is not in baseband, but that is subcarrier modulation, since the subcarrier is easily generated by dividing the frequency of the clock. The digital circuit 214 then adds the subcarrier generated in this way to the data for transmission in order to produce the signal TXD which is applied to the load modulator circuit 222.

In a variant it is possible to detect the presence of the clock signal on the contact areas CLK instead of in the signal coming from the coil (and thus the clock extractor). This requires the operation of the bistables

288 to 296 to be inverted and a clock presence detector to be added using the contact areas CLK as its input and delivering the signal PRSCLK as a replacement for the extractor 220.

Nevertheless, this variant presents various drawbacks. Thus, if communication in contact mode takes place in compliance with ISO standard 7816, the clock signal appears only after voltages have appeared on the other contact areas, and appropriate measures may be required to avoid the shunt regulator (provided for remote powering from the coil) excessively loading Vcc on starting communication with contact.

The operation of the portable device is described below with reference to the waveform diagrams of Figures 8 to 10.

The description begins with reference to the diagrams of Figure 8 by explaining how the object is powered and how it recovers the clock signal.

The tuned circuit 208 picks up a portion of the magnetic energy produced by the terminal. The corresponding alternating signal a shown in Figure 8 is rectified by the block 210 and filtered by the capacitor 212 to give a rectified and filtered voltage b as shown in Figure 8. For an alternating signal a having a peak voltage of 10 V, a rectified and filtered voltage is obtained that has a peak voltage of about 8.5 V. Naturally, the amplitude of the voltage a, and thus of the voltage b, depends greatly on the distance between the object and the terminal, with amplitude increasing as the object comes closer to the terminal. The regulator stage 216 acts to compensate for such variations, by delivering a stable voltage to the digital circuit 214, typically a voltage of the order of 3 V (waveform d in Figure 8).

Thus, when rather far away from the terminal, practically at the edge of its range, the voltage b will be fairly close to the required value of 3 V, and the

voltage drop between b and d will be small, the current passing through the shunt 228 also being very small and substantially all of the current delivered by the power supply circuit will be used for powering the digital circuit 214. It will be observed that under such circumstances the current flowing through the shunt 228 can be as low as only a few microamps (minimum bias current).

In contrast, when the object is very close to the terminal, the voltage b will be high, and the potential difference between b and d will also be large (several volts), so the current flowing through the shunt 228 will be high, the resistive element 230 and the shunt 228 then dissipating the excess power.

In addition to its purely electrical function of stabilizing the power supply to the digital circuit 214, the shunt regulator stage provides several advantages in the context of the circuit described above.

Firstly, it makes it possible to limit the excursion of the voltage at b, and thus at a, when the object is close to the terminal, because of the low load which is presented downstream from the tuned circuit 208: because of the large current flowing through the shunt 228, the power that is picked up and that is not required for powering the digital circuit 214 is entirely dissipated in the form of heat.

This is particularly advantageous when the capacitor 206 of the tuned circuit 208 is an element implemented in integrated monolithic technology, since this avoids any risk of the capacitor breaking down due to excess voltage. Given the geometrical constraints on the integrated circuit, it is not possible to make capacitors having high breakdown voltages. Unfortunately, since the digital circuit 214 is built around a microprocessor, it requires a relatively large supply of power, and thus quite a high level of magnetic field, which field is therefore also capable of generating excess voltages in

the tuned circuit unless the precautions mentioned are taken.

Secondly, as explained in greater detail, the shunt regulator has the effect of smoothing instantaneous variations in the power supply current to the digital circuit (the power consumption of such a circuit is not constant) and of avoiding them having repercussions on the operation of other members of the circuit for communication either from the object to the terminal or from the terminal to the object. Undesirable variations in current or voltage can give rise to errors in modulation or in demodulation.

Finally, when the object is at extreme range from the terminal, and thus receives only just enough signal from the terminal for powering the digital circuit, the design of the circuit serves to avoid wasting any power, since the current flowing through the shunt 220 is practically zero. Thus, all of the power picked up by the tuned circuit is available for use in powering the digital circuit.

The clock extractor circuit 220 serves to transform the alternating circuit a picked up across the terminals of the tuned circuit 208 into a series of properly shaped clock pulses c.

The way in which information is transmitted from the terminal to the object is described below with reference to the waveform diagrams of Figure 9.

To transmit information to the object, the terminal modulates the amplitude of the magnetic field that it produces. Since the information is transmitted in binary form, this modulation amounts to reducing the amplitude of the signal by a predetermined amount, e.g. 10%. Such a reduction corresponds, for example, to sending a logic "0", with amplitude remaining at its maximum for a logic "1": this can be seen in Figure 9 for the waveform diagram a of the signal as picked up by the tuned circuit 208.

After rectifying and filtering, this gives rise at b to a decrease in the amplitude of the rectified and filtered signal. This decrease in amplitude is detected by the amplitude demodulator 218 which outputs the logic signal e which is applied to the digital circuit.

It will be observed that the decrease in amplitude that results from modulation of the signal transmitted by the terminal has no effect on the clock extractor (signal c) or on the power supply voltage delivered to the digital circuit (signal d).

If techniques other than amplitude modulation are used in the terminal → object direction, e.g. phase modulation as taught in numerous prior art documents, then the type of modulation would have no direct incidence on the operation of the regulator circuit of the invention; nevertheless, this circuit is particularly advantageous when amplitude modulation is used, since, as explained, it is entirely capable of countering the various drawbacks associated with choosing the amplitude modulation technique.

The way in which information is transmitted in return from the object to the terminal is described below with reference to the waveform diagrams of Figure 10.

As mentioned above, in the embodiment shown, transmission is performed by load variation, i.e. by controlled variation of the current drawn by the tuned circuit 208. To this end, the resistive element 224 is selectively switched into circuit by the component 226: being in circuit, for example, when a logic "0" is to be sent, and being out of circuit for a logic "1".

When the resistor is in circuit, i.e. for a logic "0", the voltage a drops because of the additional load. The resistance of the resistor is naturally selected so that this voltage drop nevertheless enables proper power supply to the digital circuit to be conserved.

Nevertheless, there may be a difficultly when at extreme range from the terminal. Under such

circumstances, the current that needs to be diverted through the resistive element 224 to generate the modulation may be too high to allow the digital circuit to continue operating properly.

Under such circumstances, and before the object begins to send information to the terminal, it is advantageous to make provision for the digital circuit to be placed in a "low consumption" mode so as to be able to consume more current in the resistive element 224 without compromising the supply of power to the digital circuit.

This can be achieved, for example, by the program of the microprocessor in the digital circuit which, before beginning to send data to the terminal, places the transmission routine in RAM (which consumes little power on being accessed) and disconnects the EPROM (which consumes considerably more power on being accessed). In other words, the digital circuit is put into "low consumption" mode so as to make a large amount of current available, which current is then consumed in the modulation resistor for sending messages to the terminal.

Also, if more modulation current can be passed through the resistive element 224 (by giving it a lower resistance), then the modulation will be perceived better by the terminal, thus making it possible at the terminal to make do with detector means that are less elaborate and/or providing a better signal/noise ratio.

It is possible, still in the object → terminal direction, to use other types of modulation or to use variants, e.g. as mentioned above, modulation of a subcarrier which controls load variation instead of modulating the load directly by the signal that is to be transmitted.

THIS SHEET HAS BEEN REPLACED

CLAIMS

1/ A portable object (200) including a plurality of electrical contacts (286) for communicating over a metallic path with a terminal of a first type, itself including a plurality of corresponding electrical contacts, and also including a coil (202) for contactless communication with a terminal of a second type (100) that transmits a modulated electromagnetic field to convey data,

the portable object being characterized in that, for data transmitted by the terminal and clocked by a clock signal, it includes clock detector means (220) to modify the operation of the portable object as a function of the presence or the absence of a clock signal (CLK) in the signal received.

2/ The portable object of claim 1, characterized in that the clock detector means (220) detect the clock signal (CLK) in the signal picked up by the coil.

3/ The portable object of claim 2, comprising rectifier and filter means (210, 212) for obtaining a DC power supply voltage (d) for the object from the electromagnetic field picked up by the coil in contactless communication mode, and in which the input of the detector means receives the signal present between the coil and the rectifier and filter means.

4/ The portable object of claim 2, comprising means (218) for demodulating the signal picked up by the coil, so as to extract communication data therefrom.

5/ The portable object of claims 3 and 4 taken in combination, in which the demodulator means are amplitude demodulator means (218) operating on the signal (b) delivered at the output of the rectifier and filter stages (210, 212).

This Sheet Has Been Replaced

6/ The portable object of any one of claims 3 to 5, comprising, downstream from the rectifier and filter means, regulator means (216) for stabilizing the DC voltage, and selective inhibit means for inhibiting the regulator means under the control of the clock detector means.

7/ The portable object of any one of claims 1 to 6, comprising means (222) for transmitting data from the portable object to the terminal in contactless mode by load modulation at the terminals of the coil.

8/ The portable object of claim 7, in which the modulation performed by the data transmission means is modulation of a subcarrier produced by dividing the frequency of the clock delivered by the detector means.

9/ The portable object of claim 7 or 8, in which the circuit is capable of operating in two power consumption modes, with nominal power consumption and with low power consumption, and in which it is provided with means for placing the circuit in low consumption mode before the data transmission means begin to perform said modulation.

10/ The portable object of any one of claims 1 to 9, in which the clock detector means control protocols for communication and/or signal processing and/or received data processing.

11/ The portable object of any one of claims 1 to 10, further comprising switch means (288-296) for interrupting the links between electrical contacts (286) and other circuits of the portable object under the control of the clock detector means so as to interrupt said links whenever the portable object is communicating over a contactless path.

12/ The portable object of any one of claims 3 to 11, further comprising, downstream from the rectifier and filter stages (210, 212), a stabilizer stage (216) including a shunt regulator element (228) mounted in parallel with the circuit to be powered between its power supply terminals (VCC, GND) and associated with a resistive component (230) connected in series in the power supply line of the circuit, the shunt regulator element diverting a variable fraction of the power supply current of the circuit so that the resistive element and the shunt regulator element dissipate any excess power not required for operation of the circuit, thereby, in corresponding manner, stabilizing the power supply voltage (d) across the terminals of the circuit, limiting the voltage excursion (a) at the terminals of the upstream tuned elements, and preventing variations in current consumption having any influence upstream on the amplitude of the signal to be demodulated.

13/ The portable object of claim 12, comprising means (240) for selectively and temporarily inhibiting operation of the shunt regulator.

14/ The portable object of claims 12 and 13 taken in combination, in which the selective and temporary inhibition of the operation of the shunt regulator is applied in response to detecting communication of the type passing via contacts.

15/ The portable object of any one of claims 1 to 14, in which the entire electronic circuit (202, 204) with the exception of the coil (202) of the tuned element, is made using integrated monolithic technology.