

ELECTRONIC SYSTEM FOR IDENTIFYING
A PLURALITY OF TRANSPONDERS

The present invention relates to a contactless electronic identification system or RFID system. These systems, typically used for identifying people, animals or property (amongst other examples: vehicles, articles requiring a tag, sub-assemblies in a manufacturing line, etc.) mainly include an interrogator/reader and one or more

5 transponders each associated with an article needing to be identified.

In a system of this type, the interrogator/reader is typically arranged to transmit an interrogation signal in the form of an electromagnetic radiation. Transponders subjected to this electromagnetic interrogation field respond by generating a response signal normally consisting in a modulation of the field, and generally supply a

10 code/address identifying the transponder.

In any identification system including a plurality of transponders, there is potentially a risk that two or more transponders interrogated simultaneously generate their response signal, thus making them impossible to identify. Consequently, in order to identify each transponder individually and clearly, a communication protocol, or

15 " anti-collision protocol " has to be provided, which allows this type of conflict to be controlled efficiently. This problem has been addressed in various ways in the prior art.

Thus European Patent No. 0 494 114 discloses such an identification system where each transponder is adapted to repeat the transmission of its response signal in order to increase the probability of it being successfully received by the interrogator.

20 The delays generated between each response signal transmission are substantially longer than the duration of the response signal so as to allow identification of a large number of transponders. A temporary inhibition signal is further transmitted to each correctly identified transponder so as to separate it from the identification process and thus reduce interference with the other transponders.

25 The solution described in European Patent No. 0 494 114 has proved particularly suitable for recognising multiple transponders but it has however proved less efficient in terms of transaction time for small quantities of transponders.

" Transaction time " is

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used to mean the global time necessary to complete the executed communication process, for example the identification of each transponder interrogated. Further, because the response signals are transmitted at intervals of time which are random, i.e. not in a synchronous manner with each other, the interrogator/reader must be
5 synchronised on each response signal received.

Other identification methods are based on the development of treeing by systematically interrogating each transponder according to its unique identification code. In US Patent No. 5,489,908, for example, it is thus proposed to transmit an interrogation signal including a bit sequence intended to be compared by each
10 transponder with the least significant bits of the unique identification code stored in its memory. The transponders whose identification codes do not include this bit sequence thus suspend transmission of their response signal. The bit sequence is then adapted until only one transponder responds to the interrogation.

This identification process is efficient, since it is systematic, but is obviously
15 also a large consumer in terms of transaction time. It is also evident that two transponders having identical identification codes cannot be separately identified.

US Patent No. 5,539,394 discloses an identification system with a temporal multiplexing and division architecture. In this Patent, the interrogation signal is thus used to generate the opening of a set of response slots on which the reader and the
20 different transponders interrogated are synchronised. A distribution algorithm is used by each transponder in order to determine the response slot during which it will transmit its response signal. In order to do this, the distribution algorithm is based on a distribution parameter (equivalent to the number of response slots) as well as on the characteristic data of each transponder, i.e. its unique identification code and/or any
25 other data stored in its memory.

Upon receiving a response signal emanating from a single transponder, the reader further transmits a temporary inhibition signal removing the identified transponder from the subsequent operations. A collision occurs if several transponders transmit their response signal during the same response slot. Consequently, the
30 interrogation cycle is reinitialised on the basis of a new distribution parameter, resulting in a

different allocation of the response slots. This process is thus repeated until each transponder is identified individually.

In an embodiment presented in US Patent No. 5,539,394, the distribution algorithm consists in dividing the identification code of the transponder by a divider
5 (the distribution parameter) so as to generate a remainder corresponding to the response slot in which the transponder will transmit its response signal. The distribution parameter used as divider is equal to the number of response slots used. It follows therefrom that it is not thus possible to individually identify transponders whose identification code is identical, since these will invariably select the same response slot
10 whatever the distribution parameter used.

Moreover, in terms of transaction time, only the response slots during which a single response signal is transmitted are used in an optimum manner. The slots during which no response signal is transmitted, or during which a collision appears, generate waiting times which prolong the total transaction time in substantial proportions. It
15 happens in fact that the total transaction time constitutes a critical element when one seeks to identify a set of transponders within the shortest possible time.

A first object of the present invention is thus to propose an identification system which manages the problem linked to identifying multiple transponders potentially having identical identification codes.

20 A second object of the present invention is to propose an identification system wherein the transaction time necessary for identification of the transponders is optimised.

In order to answer in particular the first aforementioned object, the present invention concerns first a method for identifying a plurality of transponders located in a
25 communication volume defined by an electromagnetic field emanating from a read unit, the method including the following steps:

(a) transmission of said electromagnetic field allowing said transponders located in said communication volume to be activated

(b) transmission via said read unit of an interrogation signal allowing
30 synchronisation of said transponders and initialising the opening of a set of response slots intended to receive response signals

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emanating from said transponders, each of said transponders including means for selecting a response slot, from among said set of response slots, during which the transponder transmits its response signal;

(c) sequential monitoring of the response slots in order to determine
5 receptions without collision of response signals;

(d) transmission of inhibition signals allowing the suspension, at least temporarily, of the activity of transponders whose respective response signals are received without collision; and

(e) repetition of steps b) to d) until the response signals of said plurality of
10 transponders are detected without collision during step c),

this method being characterised in that said means for selecting a response slot include random selection means which, at each new interrogation signal, determine in a random manner any response slot from among said set of response slots.

15 As a result of these features, the identification method allows a reduction in the rate of collision between the different identification messages emanating from the interrogated transponders.

Indeed, one advantage of the present invention is that it allows each transponder to randomly select a response slot from among an ordered set of
20 response slots. The probability of collision is thus dependent on the number of response slots allocated and the number of transponders interrogated and no longer on the data contained in each transponder as is the case in US Patent No. 5,539,394 cited in the explanation of the prior art above.

In order to answer more precisely the second object of the invention, the
25 present invention also concerns a method for identifying a plurality of transponders located in a communication volume defined by an electromagnetic field emanating from a read unit, the method including the following steps:

(a) transmission of said electromagnetic field allowing said transponders located in said communication volume to be activated

30 (b) transmission via said read unit of an interrogation signal allowing synchronisation of said transponders and initialising the opening of a set of response slots intended to receive response signals

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emanating from said transponders, each of said transponders including means for selecting a response slot, from among said set of response slots, during which the transponder transmits its response signal;

5 (c) sequential monitoring of the response slots in order to determine the states of occupation, in particular non-use of a response slot or reception without collision of a response signal;

(d) transmission of an inhibition signal allowing suspension, at least temporarily, of the activity of a transponder whose said response signal is received without collision;

10 (e) repeating steps b) to d) until the response signals of said plurality of transponders are detected without collision during step c),

this identification method being characterised in that the global transaction time necessary to identify each of said transponders is optimised by means for reducing the duration of unused response slots.

15 As a result of these features the identification method the global transaction time necessary to identify the transponders is optimised.

Indeed, one advantage of the present invention is that it allows the transaction time to be reduced by decreasing the duration of an unused response slot, consequently allowing a very substantial time gain.

20 According to a particular implementation, the method according to the invention is further arranged to reduce the duration of a response slot during which a collision of several identification messages is detected.

Other features and advantages of the invention will appear during the following description, given solely by way of example and made with reference to the annexed drawings, in which:

25 - Figure 1 shows schematically the interrogation principle of a plurality of transponders subjected to the electromagnetic interrogation field emanating from the read unit;

30 - Figure 2 shows a simplified block diagram of a read unit according to the invention;

- Figure 3a shows a simplified block diagram of a transponder according to the invention;

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- Figure 3b shows a simplified block diagram of means allowing the random selection of a response slot according to the invention;

- Figure 4 illustrates the principle of allocation of the response slots according to the present invention;

5 - Figures 5 and 6 are flow charts describing the course of operations from the point of view of the read unit and the transponder respectively for a preferred embodiment of the invention;

- Figures 7a and 7b show a possible scenario illustrating the embodiment shown in Figures 5 and 6, wherein four transponders are interrogated by the read unit.

10 Figure 1 shows schematically the principle of interrogation of several transponders TR_i subjected to an electromagnetic field 1 transmitted by a read unit 20. Electromagnetic field 1 defines a communication volume 2 in which transponders TR_i are encompassed. Communication volume 2 represents the zone in which transponders TR_i can pick up a substantial part of electromagnetic field 1 allowing them
15 to enter into operation. Transponders TR_i are thus activated via the action of electromagnetic field 1. Transponders TR_i located outside communication volume 2 are not activated and consequently do not participate in the dialogue with read unit 20.

Generally, read unit 20 has the possibility of interrogating the transponders TR_i activated by transmitting an interrogation signal INT consisting typically of a
20 modulation of electromagnetic field 1. This interrogation signal INT indicates to transponders TR_i that read unit 20 wishes to receive a response signal REP_i including the desired information, typically the identification code of the transponder.

According to the present invention, interrogation signal INT includes in particular a sequence allowing synchronisation of all the transponders TR_i
25 interrogated. According to a particular embodiment of the present invention, it is envisaged that interrogation signal INT also includes a root code, i.e. a sequence common to a family of transponders, for example part of their identification codes, in order thus to allow preliminary filtering the activated transponders. This may prove particularly useful in order to restrict communication to a particular transponder family,
30 for example a family of keys allowing a vehicle to be opened, or a set of articles belonging to a defined class of products.

Figure 2 shows a simplified block diagram of a read unit 20 according to the present invention. The latter typically includes transmission means Tx and reception means Rx respectively allowing the transmission of interrogation signal INT and the
35 reception of response signals REP_i emanating from interrogated transponders TR_i . Modulation means 206 and demodulation means 208 respectively allowing the transmitted signals to be encoded and the received signals to be decoded. Read unit

20 further includes processing means 202 controlling the course of the communication process, these treatment means 202 being coupled to memory means 204, typically a re-programmable memory (for example an EEPROM), allowing the information received from transponders TR_i , or any other information necessary for the course of the communication process, to be stored.

Figure 3a shows a simplified block diagram of a transponder TR_i according to the present invention. The latter includes a resonant circuit 300 typically formed of an inductor and a capacitor (not shown in the Figure) connected in parallel. A modulator 306 allows the data to be transmitted to be encoded, for example, the transponder identification code, by switching the load of resonant circuit 300. Modulator 306 is controlled by a monitoring logic 302 coupled to memory means 304. These memory means 304, typically an EEPROM (or other types of re-programmable memories), contain a transponder code/address and/or any other data stored during manufacturing or subsequently.

Transponder TR_i further includes clock extraction means 312 providing monitoring logic 302 with a clock signal CLK derived from the frequency of electromagnetic field 1 transmitted by read unit 20. The data is thus encoded synchronously for each transponder.

Transponder TR_i also preferably includes detection means 314, typically a monostable, allowing detection of short interruptions in electromagnetic field 1. These detection means 314 allow, in particular, detection of interruptions in electromagnetic field 1 generated by read unit 20 and intended to transmit an instruction to transponder TR_i notifying it to modify its communication state, for example telling it to suspend its activity.

The use of transponders of the passive type will also be preferred, i.e. transponders whose power supply is extracted from the surrounding electromagnetic field, in this case electromagnetic field 1 transmitted by read unit 20. In order to do this, the power necessary for transponder TR_i to operate is extracted from electromagnetic field 1 by resonant circuit 300 and is rectified by a rectifier 308. An initialisation circuit 310 allows monitoring logic 302 to be initialised when the power supply is sufficient to guarantee proper functional operation of the transponder. It is to be noted that the use of passive type transponders is not essential to the present invention, active type transponders easily being able to be substituted for them.

With reference now to Figures 3b and 4, the general operating principle of the identification system according to the present invention will be described hereinafter, and more particularly, the principle of random selection of a response slot. Thus, in accordance with the diagram of Figure 4, following the transmission of interrogation

signal INT by read unit 20, a set of n slots $SLOT_k$ ($k=1$ to n) is generated. Each transponder TR_i includes means for selecting, in accordance with a random process, a particular response slot among the set of n response slots $SLOT_k$ available during which it will transmit its response signal REP_i .

5 The random selection process of a response slot is described in more detail hereinafter with reference to Figure 3b. This Figure shows a simplified block diagram of an example of means allowing the random selection of a response slot. Each transponder TR_i thus preferably includes an RC oscillator 402 supplying an RND clock signal CLK to a counter 404. This arrangement further includes a loading logic 400
10 allowing the instantaneous value of counter 404 to be loaded in a register 406, the value thereby loaded in register 406 being representative of the number of the response slot in which the transponder will transmit its response signal as is explained hereinafter.

RC oscillator 402 includes elements of low tolerance and high sensitivity to the
15 temperature and operating conditions. These features thus lead to great disparities between RC oscillators 402 of each transponder TR_i . These divergences further lead to a great diversity in the values provided at the output of counter 404 for each transponder.

It is to be noted that the selection of RC oscillators 402 supplying an RND clock
20 signal CLK whose frequency is substantially higher than the frequency of clock signal CLK extracted from electromagnetic field 1 will be preferred, so as to accentuate the divergences between the values representative of the number of the response slot generated by counter 404 of each transponder TR_i .

As soon as the transponder is activated, RC oscillator 402 thus supplies the
25 RND clock signal CLK, incrementing counter 404. Upon receiving interrogation signal INT, loading logic 400 proceeds to load the instantaneous value of the counter in register 406. It is to be noted that counter 404 continuously generates values as long as the transponder is activated and whichever operations are being performed. The loading instruction transmitted by loading logic 404 thus allows the instantaneous
30 value of counter 404 to be fixed in register 406.

It will be noted that the random selection process of a response slot does not allow the problem of collision to be completely eliminated. It will thus be necessary to re-execute a new interrogation cycle if a conflict between several response signals REP_i appears. Consequently, the total transaction time necessary to identify all the
35 interrogated transponders TR_i will depend on the total number of interrogation cycles performed.

According to a second aspect of the invention, the identification method is preferably arranged to allow the global transaction time necessary to identify each of the transponder to be optimised by controlling the occupation of response slots SLOT_k (k=1 to n). Three possible cases may occur during one response slot. The first case is
5 characterised by a collision-free transmission of a response signal REP during the response slot. In such case, the transponder transmitting the response signal can thus be individually identified. This transponder is then typically temporarily inhibited in order to separate it from a subsequent interrogation cycle. According to one embodiment of the present invention, read unit 20 thus transmits in inhibition signal
10 MUTE allowing suspension of the activity of the transponders whose respective response signals are received without collision.

The second case is characterised by the absence of transmission of a response signal REP during the response slot. A significant gain in terms of transaction time can thus be achieved by reducing the duration of the unused
15 response slots. It is in fact possible to determine, already after a certain period of the response slot, whether it is used or not. According to one embodiment of the present invention, the global transaction time necessary to identify each of the transponders is thus optimised by means for reducing the duration of the unused response slots.

The third case able to occur is characterised by simultaneous transmission of
20 two or more response signals during the response slot. In this case, it is also possible to determine, already after a certain period of the response slot, whether a collision appears since the data being received by the read unit are altered by the superposition of several response signals. According to one embodiment of the present invention, the transaction time necessary to identify each of the transponders is thus also
25 optimised by means for reducing the duration of the response slots during which a collision is detected.

An example embodiment of the means for reducing the duration of the response slots for the possible cases presented above will be described in more detail in the following description with reference to Figures 5 to 7. It is also important to note
30 that the optimisation of the transaction time as presented in the present description is applicable whichever selection principle is adopted (random or determining) for the response slots.

Figure 5 shows a flow chart describing the course of operations performed by read unit 20 to a preferred embodiment. The communication protocol thus starts by the
35 transmission of electromagnetic field 1, represented by block 500. The interrogation cycle is initialised at block 502 by the transmission of interrogation signal INT. This

signal thus allows synchronisation of the transponders interrogated on read unit 20 and launches the random selection process of a response slot.

As is shown schematically at block 504, it is first checked whether the interrogation cycle has reached the end. In the affirmative, read unit 20 proceeds to decision block 518 to which we will return later. In the negative, read unit 20 then scrutinises response slot SLOT in progress in order to check its state of occupation. During this operation, shown at block 506, read unit 20 tests whether a response signal REP is received after a certain period of the present response slot. If this is the case, i.e. if a positive response is supplied at the output of decision block 508, the process continues its course. In the opposite case, read unit 20 generates a slot shift signal SHIFT, this slot shift signal SHIFT indicating to all the active transponders the passage to the next response slot SLOT. This same operation, shown at block 512, is performed if a collision is detected, this thus resulting in a positive response at the output of decision block 510 indicating collision. In this case, an indicator specifying that a collision has appeared during the interrogation cycle is activated at block 511 prior to the transmission of the slot shift signal SHIFT. In the event that no collisions are detected at block 510, the process continues its course as indicated.

Upon receiving a collision-free response signal, the data transmitted by the interrogated transponder, typically its identification code, is stored at block 514 in the memory of read unit 20. This data thus stored will allow read unit 20 to subsequently address the transponder concerned. At block 516, read unit 20 generates, by way of complement, an inhibition signal MUTE indicating to the transponder concerned that it has been identified and that it can, at least temporarily, suspend its activity. Following the transmission of the inhibition signal MUTE, a slot shift signal SHIFT is also transmitted in order to indicate the passage to the next response slot SLOT.

Each response slot is thus scrutinised in accordance with the course of events presented hereinbefore, until decision block 504 indicates that the interrogation cycle has ended. If a collision has been detected during one of the response slots, in other words, if the collision indicator has been activated at block 511, it will be necessary to undertake another interrogation cycle. The interrogation cycle is thus repeated until the moment when decision block 518 no longer indicates any collisions.

At the end of the communication protocol, at block 520, it is then possible to address each individually identified transponder on the basis of the data stored at block 514.

With reference to Figure 6, the course of operations will be described from the point of view of a transponder TR for the preferred embodiment described above with reference to Figure 5. The transponder is activated, at block 600, via the action of

electromagnetic field 1 transmitted by read unit 20. The transmission of interrogation signal INT is then picked up by the transponder at block 602. This interrogation signal INT defines a temporal reference with respect to which the transponder is synchronised.

5 The random selection process of response slot SLOT is shown at the following block 604. As previously described, this selection consists in determining a number of response slot SLOT during which the transponder will transmit its response signal REP.

 Subsequently, as is indicated at block 606, transponder TR waits for the
10 selected response slot SLOT to appear. In order to do this, transponder TR counts the slot shift signals SHIFT transmitted by read unit 20 during this period until the selected response slot SLOT appears. These operations are shown at blocks 607 and 608 respectively.

 During the selected response slot SLOT, at block 609, the transponder thus
15 proceeds to transmit response signal REP. If, in parallel with this transmission, the transponder detects a slot shift signal SHIFT indicating that its response signal has had a collision, the latter suspends its transmission, as is indicated by blocks 610 and 611, and waits for a new interrogation cycle to be performed at block 602.

 In the event that the response signal has been able to be transmitted without
20 collision, the transponder waits, at block 612, for an inhibition signal MUTE to be received, indicating that the latter has been correctly identified. If this signal is received, the transponder is temporarily inhibited, as indicated at block 614, in order to separate it from the interrogated transponder population. In the opposite case, the transponder waits for a new interrogation cycle to be performed at block 602.

25 Figures 7a and 7b show a possible scenario illustrating the embodiment seen in Figures 5 and 6, wherein four transponders TR_1 to TR_4 are activated via the action of electromagnetic field 1 transmitted by read unit 20. Following the generation of interrogation signal INT, read unit 20 opens a set of n temporal response slots $SLOT_k$ in the present case 8 response slots referenced $SLOT_1$ to $SLOT_8$ have been shown by
30 way of example. Each transponder $TR_i (i=1,2,3,4)$ randomly selects a response slot during which it transmits its response signal $REP_i (i=1,2,3,4)$. In the example shown in Figures 7a and 7b, the situation is thus illustrated wherein transponders TR_1 , TR_2 , TR_3 and TR_4 have respectively selected response slots $SLOT_4$, $SLOT_7$, $SLOT_2$ and $SLOT_4$. It will thus be noted that response signals REP_1 and REP_4 of transponders TR_1 and
35 TR_4 collide during response slot $SLOT_4$.

 Since response slots $SLOT_1$, $SLOT_3$, $SLOT_5$, $SLOT_6$ and $SLOT_8$ are not used by any of transponders $TR_i (i=1,2,3,4)$, a slot shift signal SHIFT is thus generated after

a certain period of the response slot. A slot shift signal SHIFT is also generated during response slot SLOT₄ following the collision between response signals REP₁ and REP₄ of transponders TR₁ and TR₄ respectively, this slot shift signal SHIFT being interpreted by transponders TR₁ and TR₄ so that they suspend the transmission of response signals REP₁ and REP₄.

5 An inhibition signal MUTE is transmitted to transponders TR₂ and TR₃ for which reception was able to be performed without collision. Transponders TR₂ and TR₃ are thus temporarily separated from the interrogated transponder population. This inhibition signal MUTE is followed by a slot shift signal SHIFT in order to indicate
10 passage to the next response slot.

A second interrogation cycle (not shown) has to be performed so as to recognise the two remaining transponders TR₁ and TR₄. It will be understood thus that the probability of a collision again appearing during the next interrogation cycle is slight.

15 Figure 7b illustrates the scenario described above in the form of temporal diagrams schematically showing response signals REP_i emanating from each transponder TR_i (i=1,2,3,4), as well as signals MUTE and SHIFT transmitted by read unit 20. This Figure further shows that the duration of the response slots during which no response signal is transmitted or during which a collision is detected, is reduced by
20 the transmission of slot shift signals SHIFT, thus allowing a substantial reduction in the duration of the interrogation cycle.

The slot shift signals SHIFT and temporary inhibition signals MUTE are preferably formed of one of more momentary interruptions to electromagnetic field 1 transmitted by read unit 20. For this purpose, detection means 314 associated with
25 monitoring logic 302 (Figure 3a) of each transponder are used to check whether such characteristic interruptions in a shift signal SHIFT or an inhibition signal MUTE are generated by read unit 20.

It will be noted in the embodiment described above with reference to Figures 5 to 7, a slot shift signal SHIFT is transmitted so as to indicate passage to the next
30 response slot. Each transponder counts the slot shift signals SHIFT transmitted by the read unit until the selected response slot appears. It is thus possible to prolong if necessary the duration of a response slot, for example so as to address a transponder as soon as the latter has been identified.

Alternatively, it is also proposed to fix a determined duration for each response
35 slot, this duration having to be sufficient to allow transmission of a response signal. In such case, a slot shift signal is then only necessary in the event that the response slot is not used or a collision is detected. Further, slot shift signal SHIFT can thus be

interpreted by the active transponders so that they bring forward the transmission of their response signal by a duration corresponding to the remaining duration of the response slot.

- It will be noted finally that certain applications do not necessarily require
- 5 identification of all the transponders interrogated. Thus, for example, a remote vehicle opening system with which a set of transponders (or keys) is associated requires identification only of the first transponder transmitting its response signal without any collision, within the shortest possible time. In the illustration of Figure 7a, this thus means the end of the interrogation cycle upon reception of response signal REP₃
- 10 emanating from transponder TR₃.



CLAIMS

1. Method for identifying a plurality of transponders (TR_i) located in a communication volume (2) defined by an electromagnetic field (1) emanating from a read unit (20), the method including the following steps:
 - (a) transmission of said electromagnetic field (1) allowing said transponders
5 (TR_i) located in said communication volume (2) to be activated
 - (b) transmission via said read unit (20) of an interrogation signal (INT) allowing synchronisation of said transponders (TR_i) and initialising the opening of a set of response slots ($SLOT_k$, $k=1$ to n) intended to receive response signals (REP_i) emanating from said transponders (TR_i), each of said transponders (TR_i) including
10 means for selecting a response slot, from among said set of response slots ($SLOT_k$, $k=1$ to n), during which the transponder transmits its response signal;
 - (c) sequential monitoring of the response slots in order to determine receptions without collision of response signals (REP_i)
 - (d) transmission of inhibition signals (MUTE) allowing the suspension, at
15 least temporarily, of the activity of transponders whose respective response signals (REP_i) are received without collision; and
 - (e) repetition of steps b) to d) until the response signals of said plurality of transponders are detected without collision during step c),this method being characterised in that said means for selecting a response
20 slot include random selection means which, at each new interrogation signal (INT), determine in a random manner any response slot from among said set of response slots ($SLOT_k$, $k=1$ to n).
2. Identification method according to claim 1, characterised in that the
25 global transaction time necessary to identify each of said transponders (TR_i) is optimised by means for reducing the duration of unused response slots.
3. Identification method according to claim 1 or 2 wherein said sequential monitoring of the response slots ($SLOT_k$, $k=1$ to n) is provided also to detect a collision between several response signals in any response slot, characterised in that the
30 global transaction time necessary to identify each of said transponders (TR_i) is optimised by means for reducing the duration of slots in which a collision between several response signals (REP_i) is detected.
4. Identification method according to claim 1, 2 or 3, characterised in that said random selection means (402) include means allowing a random clock signal (RND CLK) to be generated during the duration of the activation of the transponder,
35 means (404) allowing a cyclic incrementation, on the basis of said random clock signal

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(RND CLK), of a value representative of a response slot, means (400, 406) allowing this value representative of the selected response slot to be loaded during transmission of said interrogation signal (INT).

5 Identification method according to claim 4, characterised in that the frequency of said random clock signal (RND CLK) is substantially higher than the frequency of a clock signal used for the internal operation of said transponders (TR_i).

6. Method for identifying a plurality of transponders (TR_i) located in a communication volume (2) defined by an electromagnetic field (1) emanating from a read unit (20), the method including the following steps:

10 (a) transmission of said electromagnetic field (1) allowing said transponders (TR_i) located in said communication volume (2) to be activated

(b) transmission via said read unit (20) of an interrogation signal (INT) allowing synchronisation of said transponders (TR_i) and initialising the opening of a set of response slots ($SLOT_k$, $k=1$ to n) intended to receive response signals (REP_i)
15 emanating from said transponders (TR_i), each of said transponders (TR_i) including means for selecting a response slot ($SLOT_k$, $k=1$ to n), from among said set of response slots, during which the transponder transmits its response signal;

(c) sequential monitoring of the response slots ($SLOT_k$, $k=1$ to n) in order to determine their states of occupation, in particular non-use of a response slot or
20 reception without collision of a response signal (REP_i);

(d) transmission of an inhibition signal (MUTE) allowing suspension, at least temporarily, of the activity of a transponder whose said response signal (REP_i) is received without collision;

(e) repetition of steps b) to d) until the response signals of said plurality of
25 transponders are detected without collision during step c),

this identification method being characterised in that the global transaction time necessary to identify each of said transponders (TR_i) is optimised by means for reducing the duration of unused response slots.

7. Identification method according to claim 6 wherein said sequential
30 monitoring of the response slots is provided also to detect a collision between several response signals in any response slot ($SLOT_k$, $k=1$ to n), characterised in that the global transaction time necessary to identify each of said transponders (TR_i) is optimised by means for reducing the duration of slots in which a collision between several response signals (REP_i) is detected.

35 8. Identification method according to any of claims 1 to 7, characterised in that said inhibition signal (MUTE) consists of one or more momentary interruptions of said electromagnetic field (1).





9. Identification method according to any of claims 1 to 8, characterised in that said interrogation signal (INT) further includes a root code representative of a determined family of transponders, said root code allowing preliminary filtering of all the transponders not belonging to said family of transponders.

- 5 10. Read unit (20) allowing identification of a plurality of transponders (TR_i) located in a communication volume (2) defined by an electromagnetic field (1) emanating from said read unit (20), said read unit (20) including transmission means (Tx) connected to modulation means (206), reception means (Rx) connected to demodulation means (208), processing and checking means (202) and memory
- 10 means (204), said read unit (20) being arranged to:
- (a) activate said transponders (TR_i) by the transmission of said electromagnetic field (1);
 - (b) transmit an interrogation signal (INT) allowing synchronisation of said transponders (TR_i) and initialising the opening of a set of response slots ($SLOT_k$ $k=1$ to
 - 15 n) intended to receive response signals (REP_i) emanating from said transponders (TR_i);
 - (c) monitor sequentially each of the response slots ($SLOT_k$ $k=1$ to n) in order to determine their state of occupation, in particular non-use of a response slot or reception without collision of a response signal (REP_i);
 - 20 (d) transmit an inhibition signal (MUTE) allowing suspension, at least temporarily, of the activity of a transponder whose said response signal (REP_i) is received without collision; and
 - (e) repeat steps b) to d) until the response signals of said plurality of transponders are detected without collision,
 - 25 this read unit (20) being characterised in that it is further arranged to transmit a duration reduction signal for any response slot when no response signal (REP_i) is received in said response slot.

11. Read unit (20) according to claim 10, characterised in that it is also arranged to transmit a duration reduction signal for a response slot when a collision
- 30 between several response signals (REP_i) is detected in said response slot.

12. Transponder (TR) including communication means (300, 306), processing and checking means (302), memory means (304) and means responding to the reception of an interrogation signal (INT) emanating from a read unit (20) and allowing a response slot to be selected, from a set of response slots ($SLOT_k$ $k=1$ to n),
- 35 during which said transponder transmits a response signal (REP), said transponder being arranged to suspend its activity, at least temporarily upon reception of an inhibition signal (MUTE), said transponder being characterised in that said means for



selecting a response slot include random selection means which, at each new interrogation signal (INT), determine in a random manner any response slot from among said set of response slots ($SLOT_k$ $k=1$ to n).



This Sheet Has Been Replaced

