ENHANCED IDENTIFICATION SYSTEM

This invention relates to a method of identifying a plurality of transponders, each of which transmits data at intervals to a receiver. The invention also relates to an identification system comprising a plurality of transponders and a receiver, and to the transponders and receivers themselves. The invention further relates to method and apparatus for improving the identification systems disclosed in EP 494,114 A and EP 585,132 A.

Identification systems are known in which a plurality of transmitters, typically transponders, are activated by a power signal (or an "interrogation signal") and then transmit reply signals, usually containing identification data, to a receiver, which typically forms part of the interrogator. The signals may be transmitted in many ways, including electromagnetic energy, e.g. radio frequency (RF), infra red (IR), and coherent light, and sound, e.g. ultrasound. For example, the transmission may be achieved by actual emission of RF energy by the transponders, or by the modulation of the reflectivity of an antenna of the transponder, resulting in varying amounts of RF energy in the interrogation signal being reflected or back-scattered from the transponder antenna.

GB 2,116,808 A discloses an identification system in which the individual transponders are programmed to retransmit data in a pseudo-random manner. Timing signals for the transponders in this identification system are derived from a crystal oscillator, thereby making the transponders expensive to manufacture.

EP 467,036 A describes another identification system which uses a pseudo-random delay between transponder data transmissions. In this example, a linear recursive sequence generator is seeded by the transponder identification address to make the pseudo-random delay as random as possible.

EP 161799 A discloses an interrogator/transponder system in which an interrogator broadcasts an interrogation signal to a plurality of transponders present in the interrogation field. Each transponder transmits a reply signal consisting of a uniquely coded identification number. The interrogator then re-transmits the signal it has received and each transponder decodes the signal and checks the data against it's own identification number. In the event that a particular transponder recognizes it's

own code, that transponder discontinues the reply signal or adjusts to receive further instructions (all others having shut down). If interference occurs because two or more transponders are transmitting at the same time, the interrogator waits until a valid signal is received.

EP 494112 A discloses another interrogator/transponder system in which an interrogator broadcasts an interrogation signal to a plurality of transponders present in the interrogation field. One example of the identification system comprises an interrogator or reader which transmits interrogation signals at a power of approximately 15W and at a frequency of approximately 915 MHZ to a number of passive transponders. The transponders derive a power supply from energy in the interrogation signal, and modulate a portion of the energy received from the interrogator with an identification code to generate a response signal, which is transmitted back to the interrogator.

EP 585,132 A discloses another interrogator/transponder system in which transponders are provided with local timing means which is dependent on the power supply voltage derived from the interrogation signal, thereby causing the clock frequencies of different transponders to vary relatively widely. The interrogator is adapted to detect successful reception of a response signal from any transponder and to derive a synchronisation signal from the response signal. The interrogation signal may then be modified synchronously with a particular transponder.

The transponder can use separate receiver and transmitter antennas, or a single antenna can be utilised for both reception and transmission. If a single antenna is used the response signal can be generated by modulating the reflectivity of such an antenna; if separate receiver and transmitter antennae are used then a modulator which redirects energy from the receiver antenna to the transmitter antenna is required. Alternatively, the transponder can be independently powered and may generate its own response signal.

The system described in the above mentioned patent application provides for each transponder to wait for a random or pseudo-random period after receiving an interrogation signal from the interrogator, before transmitting its own response signal. Successful identification of any transponder is indicated by a brief interruption or other modification of the interrogation signal, following closely on the successful reception of

a response signal of any particular transponder. This acts as a turn-off signal to the relevant transponder. The random or pseudo-random delay in the generation of response signals, in response to repeated interrogation signals, ensures that all transponders will eventually be identified by the interrogator.

In general, if the transmissions of two transponders overlap or clash, the transmissions are polluted and therefore lost, since the receiver cannot distinguish the separate transmissions. Thus, the system must provide for each transponder to transmit repeatedly until its entire transmission takes place in a "quiet" time and is successfully received by the interrogator.

Any transponder must obtain a quiet time which is as long as the entire length of the data stream to be transmitted. As shown in Figure 1, there is considerable wasted time in systems which employ a back-off and retry algorithm of this sort.

EP 689 151 A2 discloses another interrogator/transponder system in which the RFID tag transmit a request to transmit (RTT) signal and wait for an acknowledgement signal from the network controller before attempting to transmit data. The disadvantage with such a system is that the tag must wait for, and decode, an appropriately timed permission before attempting to transmit data, thereby adding unnecessary complexity to the tag and leading to considerable wasted time in the transmission cycle. If the tags are to have local timing means (as described in detail in EP 585,132 A) the timing and the duration of the acknowledgment instruction must be derived from the local timing means of the tag transmitting the RTT signal. Since the RTT signal must necessarily be very short in order to provide the advantages suggested, the network controller must be able to extract the timing from very little information. This adds unnecessary complexity to the network controller.

It is an object of this invention to provide an improved, yet simple, identification system with improved recognition of data signals. It is also an object of this invention to remove wasted time, to improve the speed of identifying a plurality of transponders without adding unnecessary complexity to the identification systems.

It is also an object of the present invention to provide an identification system in which wasted time due to transmission pollution is considerably reduced while still providing a reasonably fast tag transmitting cycle.

According to a first aspect of the invention, there is provided an identification system comprising a reader including a transmitter for transmitting a signal and a plurality of transponders, each transponder including a receiver for receiving the reader signal and a transmitter for generating a transponder signal, characterised in that on recognising a transponder signal from a transponder the reader immediately issues a mute instruction, muting all other active transponders and passing control to the said transponder, without the need for a specifically timed acknowledgement to the said controlling transponder.

According to a second aspect of the invention, there is provided a method of identifying a plurality of transponders comprising transmitting a reader signal, and each transponder receiving the reader signal, characterised in that on recognising a transponder signal from a transponder the reader immediately issues a mute instruction, muting all other active transponders and passing control to the said transponder, without the need for a specifically timed acknowledgement to the said controlling transponder.

In a further aspect of the invention, there is provided a transponder comprising receiver means for receiving a reader signal, transmission means for transmitting a transponder signal containing data which identifies the transponder whereby in a set of transponders, two or more transponders may transmit their transponder response signals in response to receiving the reader signal, characterised in that the transponder is provided with control means, whereby on recognising a mute instruction in the reader signal, all active transponders in the set but one are muted and control is passed to said one transponder, without the need for a specifically timed acknowledgement to the said controlling transponder.

In a yet further aspect of the invention there is provided an integrated circuit for use in a transponder, comprising receiver means for receiving a reader signal, transmission means for transmitting a transponder signal containing data which identifies the transponder whereby in a set of transponders, two or more transponders may transmit their transponder response signals in response to receiving the reader signal, characterised in that there is provided control means, whereby on recognising a mute instruction in the reader signal, all active transponders in the set but one are muted

and control is passed to said one transponder, without the need for a specifically timed acknowledgement to the said controlling transponder.

In a further aspect of the invention there is provided a reader comprising transmitter means for transmitting an interrogation signal to at least one transponder, at a time when at least one other transponder may transmit in response to the interrogation signal, and receiver means for receiving a response signal from a transponder, characterised in that on recognising a transponder signal from the transponder the reader immediately issues a mute instruction, muting all other active transponders, and passing control to said transponder, without the need for a specifically timed acknowledgement to the said controlling transponder.

The mute instruction may take the form of a total or partial interruption in the reader signal, or some other modulation of the reader signal. Alternatively, the mute instruction may be a separate signal transmitted by the reader, for example at a frequency which differs from the reader signal.

An acceptance instruction may be sent after the transponder signal has been successfully received by the reader. The acceptance instruction may be of a similar nature to the mute instruction, such as a total or partial interruption or other modulation of the reader signal. Alternatively, the acceptance instruction may be transmitted at a frequency which differs from the reader signal; such a frequency may also differ from the frequency of the mute instruction. The acceptance instruction may also have a different duration to the mute instruction, or be formed by repeating the mute instruction within a predetermined period, e.g. using single and double pulses.

The mute instruction may mute the remaining active transponders by halting the random wait cycle of the transponders until either restarted or reset by another instruction. If the random wait cycles of the remaining active transponders are halted by the mute instruction, the acceptance instruction may also instruct the remaining active transponders in the reader field to restart the existing random wait cycles. Alternatively, the acceptance instruction may cause the remaining active transponders to begin new random wait cycles.

The mute instruction may simply mute a transponder by inhibiting the said transponder from transmitting. Any transponder which reaches the end of its random

wait cycle is inhibited from transmitting the transponder signal. For example, the mute instruction may set a flag and when a transponder reaches the end of its random wait cycle it checks to see whether the flag is set before transmitting. The transponder inhibit may be reset by the acceptance signal or be reset after a predetermined time.

The acceptance instruction may also act as a disabling instruction, disabling the transponder which has just transmitted either permanently, for a predetermined period of time or until it is reset. Thus a single acceptance instruction may be used to disable a transponder which has been successfully identified, and to instruct the remaining muted tags to continue with the existing, or begin new, random wait cycles.

The transponders may, instead of being reactivated by an acceptance instruction to the controlling transponder, remain muted for a predetermined period of time. The transponders random wait cycle may include a delay equal to the length of a transponder signal; if a disabling instruction is used then the delay may also include the period for the reader to transmit the disabling instruction.

If transponders with local timing means (as described in detail in EP 585,132 A mentioned above) are employed, the acceptance instruction, if used, may be synchronised with the particular timing means of the controlling transponder.

The frequency and duration (i.e. the timing) of the interrogator instructions may be preset in the interrogator at manufacture or installation. The timing may be set in an optimisation phase, e.g. after installation or the timing may be optimised in an initial interrogation and used in subsequent interrogations.

If the transponders within the interrogation field are programmed with unique codes, the acceptance instruction may be eliminated altogether, and the transponders may thereby provide for the continued surveillance of the articles to which the transponders are attached. If all the transponders are programmed with the same code and the disabling instruction is used, the number of transponders within the interrogation field may be counted. The transponders may be used as a "presence tags", indicating the number of articles to which the transponders are attached, and the response code may therefore be very simple. Selective use of the acceptance signal may provide more flexibility to an identification system.

Transponders and interrogators, such as those described in EP 494,114 A and EP 585,132A (the entire contents of which are incorporated herein by reference), may be adapted to produce transponders and interrogators according to the invention.

The invention will now be described in further detail. Specific non-limiting embodiments are hereinafter described with reference to the accompanying drawings, in which:

Figure 1 is a simplified representation of prior art transponder data transmissions;

Figure 2 is a simplified block diagram showing an interrogator and three transponders according to a first embodiment of the invention;

Figure 3 is a simplified representation of an interrogator and a number of transponders;

Figure 4 is a block diagram of a transponder according to the first embodiment of the invention;

Figure 5 shows a timing diagram of a transponder according to the first embodiment of the invention;

Figure 6 shows a flow diagram for a transponder according to the first embodiment of the invention;

Figure 7 shows a detailed diagram of a gap detector circuit according to the first embodiment of the invention.

Figure 8 shows the circuit for the interrogator of the first embodiment of the invention.

Figure 9 shows a timing diagram of a transponder according to a second embodiment of the invention;

Figure 2 shows an example of the RFID system comprising a reader 10, including a transmitter 11 with a transmitting antenna 11a and a receiver 12 with a receiving antenna 12a. The transmitter (11, 11a) transmits a powering signal (the reader signal) to a number of passive transponders (tag 1, tag 2 and tag 3).

Each transponder includes a dipole antenna, the two poles of which are indicated by 4 and 5. The transponders within the reader field are able to derive a power supply from the energy in the reader signal using the capacitor C and the diode D. The code generator 6 and logic circuit 7 generate a signal using Manchester coding, which is

transmitted to the reader, by modulating a portion of the energy received from the reader using the modulator 9 connected between the antenna poles 4 and 5. The transponders have local timing means (as described in detail in EP 585,132 A mentioned above).

On receiving power each transponder executes a random wait cycle before transmitting a signal. If a signal is received the reader issues a mute instruction. The mute instruction may consist of a short gap (a partial or complete interruption) in or other modification of the signal. All other active transponders within the reader field are temporarily muted by the broadcast of the mute instruction, which is recognised as giving control to another transponder. The reader issues an acceptance instruction (disable/wakeup instruction) once the transponder signal has been received free from noise or interference. Since the transponders have local timing means (as described in detail in EP 585,132 A mentioned above) the timing and the duration of this instruction is synchronised with the local timing means. The random wait cycles of these transponders are reactivated by this disable/wakeup instruction.

Figure 3 represents the reader signal and the replies from the transponders. The reader signal 20 is powered up a time t_0, whereupon the transponders within the reader field are powered and begin random wait cycles. In the example shown in figure 3, tag 1 transmits a signal 20 at time t_1 The reader recognises a transponder signal and, by interrupting the reader signal at time t_2, makes mute instruction 21 which halts the random wait cycles of tags 2 and 3. When tag 1 has completed transmitting the signal 20 the reader issues an instruction 22 at time t_3.

In the example shown in figure 3, tags 2 and 3 are temporarily muted by the broadcast of the mute instruction 21 at time t_3. Tags 2 and 3 are instructed to resume the random wait cycle by the broadcast of the disable/wakeup instruction 22, which also disables tag 1 until it is removed from the field. In this figure, the read process is then successfully completed for tag 3 followed by tag 2.

Figure 4 shows, in outline, tag which may be used with the reader of figure 2 and figure 5 shows a timing diagram for the signal paths marked in figure 4. The tag includes a dipole antenna, the poles of which are shown as 60 and 61. A code generator 62, when enabled by a logic circuit 64 modulates a transistor Q1 with a code, using Manchester coding (signal 77). The timing for the code generator is derived from a

local oscillator 66. Diodes D1 and D2 in combination with a capacitor C1 supply the power for tag. The oscillator is disconnected from the random wait time generator when either FF1 or FF2 is in the reset state (signals 70 and 72). FF1 is set only when the tag is powered up and resets when the tag is switched off after being read successfully. FF2 is in the reset state when the tag is muted and in the set state on power up and when the tag is in its normal operating mode. When the tag initially receives the reader signal FF1 will be in the set state. On power up the logic circuit 64 triggers the random wait timer 63 to select a random value and begin a countdown.

The gap detector circuit 65 is able to detect the presence or absence of the reader signal by means of diode D3 and, if there is an interruption or gap in the reader signal, the duration of the gap. The gap detector circuit is shown in more detail in figure 7.

A long gap (a disable/wakeup instruction) will set FF2 and a short gap (mute instruction) will reset FF2. Therefore a disable/wakeup gap from the reader is detected by the gap detector which sets FF2, which enables the random wait time generator to run. The random wait time generator indicates (signal 75) the end of the countdown to the logic circuit 64 which then enables (signal 76) the code generator 62 to modulate transistor Q1 with the code. The logic circuit also inhibits the gap detector circuit for the time tag takes to transmit the signal. If, during the countdown a mute gap from the reader is received (passing control to another transponder) the gap detector switches FF2 into the reset state, thereby disconnecting the oscillator (signal 73) and pausing the countdown. FF2 remains in the reset state until another pulse from the reader is received (the disable/wakeup gap which disables the controlling transponder). The random wait timer then continues the countdown until either the transponder signal is transmitted or another mute gap is received.

If the reader issues an appropriately timed disable/wakeup gap once the transponder signal has been received by the reader free from noise or other interference. The gap detector circuit detects this gap and indicates the presence of this gap to logic circuit 64. Provided that this gap occurs at a predetermined time after the end of the transponder signal, e.g. 5 clock pulse after the end of the code, logic circuit 64 (signal 71) will reset FF1. FF1 (signal 72) disconnects the oscillator until it is reset, in this case after removing the tag from the field and allowing capacitor C1 to discharge sufficiently.

If it is not necessary for the tags to be switched off after successful detection of the transponder signal, flip-flop FF1 and switch SW1 may be omitted entirely from the tag.

Figure 6 shows a flow diagram for the operation of the tag illustrated in figure 4.

The gap detector circuit 65 is shown in more detail in figure 7. When a gap appears in the interrogation (a mute gap), the output of D3 goes low. The edge detector circuit 102 detects a falling edge on the output of D3, which in turn resets FF2. The output of OR gate 100 then passes pulses from the oscillator 66 to the counter 101. When the counter reaches a value sufficient to make output Q4 go high, FF2 is set. When the output of D3 returns to high (the end of the mute gap) the counter is reset. If the gap is short, counter 101 is rest before Q4 would have gone high. FF2 gets reset at the beginning of the gap and remains in this condition after the gap. If the gap is long, FF2 is still reset at the beginning of the gap. When counter 101 has counted up sufficiently for Q4 to go high, FF2 is set and it remains in this set state after the gap.

Figure 8 shows the circuit for the interrogator. The transmitter 110 produces a reader rf continuous wave signal which is transmitted to the tags via the circulator 111 and the antenna 112. The tag signal is received by the antenna 112 and passed via the circulator 111, to separate it from the transmitter signal, to the mixer 113, which extracts the low frequency code signal, and to the low pass filter 114. The mixers 113 mixes the tag's signal with a portion of the transmitted reader signal extracted by splitter 118 thereby generating the baseband signal which is fed to filter 114. The outputs of the filter is then amplified 119 and full wave rectified 121. The resulting signal is then amplified and passed, via a divide by two circuit 125 to the microprocessor 126. The microprocessor may interrupt the reader signal with either a short or a long gap, using either the short monostable 127 or the long monostable 128, the AND gate 129 and switch 130.

Referring to Figure 9 in a second embodiment of the invention the interrogator is adapted to provide a double pulse wakeup or acceptance instruction and single pulse for the mute instruction. The transponder is adapted to distinguish between the signals. In particular, in the transponder the gap detector details circuit 68 is adapted to sense for the occurrence of 1 or 2 "short" pulses of the same duration and to provide the Set 5

signal to FF2 on occurrence of 2 pulses and the Reset R signal to FF2 on occurrence of 1 pulse.

It will be immediately appreciated by those skilled in the art the functionality of the tags and reader may be achieved in a number of different ways. For example, the tags, instead of deriving power from the reader signal, may be powered by a small battery.

In a further embodiment the integrated circuit of the transponder has read/write capabilities. Instructions sent from the reader to the transponder may take the form of coded instructions included in the mute and./or acceptance instructions. For example, if the mute and/or acceptance instructions are in the form of interruptions in the reader signal, the coded instructions may be present in the gaps in the reader signal defined by those interruptions.

In the embodiments above the reader, on recognising the transponder signal from a transponder, immediately issues a mute instruction, muting all other active transponders, and passing control to the transponder. Preferably the mute instruction is transmitted as soon as the reader recognises, or there is a high probability that the reader has recognised, a valid signal from the transponder. In one embodiment the first few pulses in the signal from the transponder may have a unique shape or characteristic thereby enabling the reader to distinguish quickly whether or not the signal received is from the transponder as opposed to being the product of spurious noise.

CLAIMS

1. An identification system comprising

a reader including a transmitter for transmitting a signal

and a plurality of transponders, each transponder including a receiver for receiving the reader signal and a transmitter for generating a transponder signal,

characterised in that on recognising a transponder signal from a transponder the reader immediately issues a mute instruction, muting all other active transponders and passing control to the said transponder, without the need for a specifically timed acknowledgement to the said controlling transponder.

2. An identification system as claimed in claim 1, characterised in that the mute instruction comprises a modulation of the reader signal.

3. An identification system as claimed in claim 1, characterised in that the reader issues an acceptance instruction after the controlling transponder signal has been successfully received by the reader.

4. An identification system as claimed in claim 3, characterised in that the acceptance instruction comprises a modulation of the reader signal.

5. An identification system as claimed in claims 2 or 4, characterised in that the modulation comprises a total interruption of the reader signal.

6. An identification system as claimed in claims 2 or 4, characterised in that the modulation comprises a partial interruption of the reader signal.

7. An identification system as claimed in claims 2 or 3, characterised in that the instruction is signal transmitted independently from the reader signal.

8. An identification system as claimed in claim 4, characterised in that acceptance instruction uses the same modulation of the reader signal as the mute instruction.

9. An identification system as claimed in claim 8, characterised in that the acceptance modulation has a different duration to the mute modulation.

10. An identification system as claimed in claim 9, characterised in that the mute instruction comprises a short interruption in the reader signal and the acceptance instruction comprises a longer interruption in the reader signal.

11. An identification system as claimed in claim 1, characterised in that the transponder includes a random wait timer which triggers the transmission of the transponder signal after a random wait cycle has been completed.

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12. An identification system as claimed in claim 11, characterised in that if a transponder receives a mute instruction before it has begun transmitting a transponder signal, the random wait cycle of said transponder is halted.

13. An identification system as claimed in claim 12, characterised in that the random wait cycle of the said transponder is restarted by an acceptance instruction issued by the reader.

14. An identification system as claimed in claim 12, characterised in that the random wait cycle of the said transponder is reset by an acceptance instruction issued by the reader.

15. An identification system as claimed in claim 12, characterised in that the random wait cycle of the said transponder is reset after a predetermined time of time.

16. An identification system as claimed in claim 11, characterised in that if a transponder receives a mute instruction before it has begun transmitting a transponder signal, the transponder is inhibited from transmitting the transponder signal at the end of the random wait cycle.

17. An identification system as claimed in claim 1, characterised in that the reader issues a disabling instruction after the controlling transponder signal has been successfully received by the reader.

18. An identification system as claimed in claim 17, characterised in that the controlling transponder is permanently disabled by a disabling instruction.

19. An identification system as claimed in claim 17, characterised in that the controlling transponder is disabled for a predetermined period of time after the disabling instruction is issued.

20. An identification system as claimed in claim 17, characterised in that the controlling transponder is disabled by the disabling instruction until it is reset.

21. An identification system as claimed in claims 1 or 3, characterised in that the transponders include local timing means.

22. An identification system as claimed in claim 21, as dependent on claim 3, characterised in that the reader synchronises the acceptance instruction with the local timing means of the controlling transponder.

23. An identification system as claimed in claim1, characterised in that each transponder generates the same transponder signal.

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24. An identification system as claimed in any of claims 1 to 23, characterised in that the circuitry on the transponder is in the form of an integrated circuit having read/write capabilities.

25. An identification system as claimed in claim 24, characterised in that instructions sent from the reader to the transponder include coded instructions incorporated in the mute instructions.

26. An identification system as claimed in claim 24 or claim 25, when dependent on claim 3, characterised in that instructions sent from the reader to the transponder include coded instructions incorporated in the acceptance instruction.

27. An identification system as claimed in claim 25 or claim 26, characterised in that the mute an/or acceptance instructions are in the form of interruptions in the reader signal, the coded instructions being present in the gaps in the reader signal defined by those interruptions.

28. An identification system as claimed in claim 5; 6; 10 or 27, characterised in that each transponder includes a gap length detector circuit for determining the length of the interruption in the reader signal.

29. An identification system as claimed in claim 28, characterised in that the gap length detector circuit detects a mute instruction and pauses the random wait cycle.

30. An identification system as claimed in claim 29, characterised in that the gap length detector circuit detects an acceptance instruction and enables the random wait cycle to resume.

31. A method of identifying a plurality of transponders comprising

transmitting a reader signal, and

each transponder receiving the reader signal,

characterised in that on recognising a transponder signal from a transponder the reader immediately issues a mute instruction, muting all other active transponders and passing control to the said transponder, without the need for a specifically timed acknowledgement to the said controlling transponder.

32. A method as claimed in claim 31, characterised in that an acceptance instruction is issued by the reader after the controlling transponder signal has been successfully received.



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33. A method as claimed in claim 31, characterised in that the transmission of the transponder signal by each transponder is triggered after a random wait cycle has been completed.

34. A method as claimed in claim 31, characterised in that if a mute instruction is received by a transponder before it has begun transmitting its transponder signal, the random wait cycle of said transponder is halted.

35. A method as claimed in claim 34, characterised in that the random wait cycle of the said transponder is restarted by an acceptance instruction issued by the reader.

36. A method as claimed in claim 31, characterised in that if a mute instruction is received by a transponder before it has begun transmitting a transponder signal, at the end of the random wait cycle the transponder is inhibited from transmitting the transponder signal.

37. A method as claimed in claim 31, characterised in that a disabling instruction is issued by the reader after the controlling transponder signal has been successfully received by the reader.

38. A method as claimed in claim 31, characterised in that the controlling transponder is permanently disabled by a disabling instruction.

39. A method as claimed in claim 31, characterised in that when a transponder detects a mute instruction the random wait cycle is paused.

40. A method as claimed in claim 39, characterised in that when a transponder detects an acceptance instruction the random wait cycle is resumed.

41. A method as claimed in any one of claims 31 to 40, characterised in the circuitry on the transponder is in the form of an integrated circuit having read/write capabilities.

42. A method as claimed in claim 41, characterised in that instructions sent from the reader to the transponder include coded instructions incorporated in the mute instructions.

43. A method as claimed in claim 41 or claim 42, when dependent on claim 32, characterised in that instructions sent from the reader to the transponder include coded instructions incorporated in the acceptance instruction.

44. A method as claimed in claim 42 or claim 43, characterised in that the mute and/or acceptance instructions are in the form of interruptions in the reader

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coded instructions being present in the gaps in the reader signal defined by those interruptions.

45 A transponder comprising receiver means for receiving a reader signal, transmission means for transmitting a transponder signal containing data which identifies the transponder whereby in a set of transponders, two or more transponders may transmit their transponder response signals in response to receiving the reader signal, characterised in that the transponder is provided with control means, whereby on recognising a mute instruction in the reader signal, all active transponders in the set but one are muted and control is passed to said one transponder, without the need for a specifically timed acknowledgement to the said controlling transponder.

46. A transponder as claimed in claim 45, characterised in that the mute instruction from the reader comprises a modulation of the reader signal and the transponder has detection means for recognising the modulation.

47. A transponder as claimed in claim 46, characterised in that the control means of the transponder can detect an acceptance instruction in the reader signal after the controlling transponder signal has been successfully received by the reader.

48 A transponder as claimed in claim 47, characterised in that the acceptance instruction comprises a modulation of the reader signal.

49 A transponder as claimed in claims 46 or 48, characterised in that the modulation comprises a total interruption of the reader signal.

50 A transponder as claimed in claims 46 or 48, characterised in that the modulation comprises a partial interruption of the reader signal.

51 A transponder as claimed in claims 46 or 48, characterised in that the instruction is signal transmitted independently from the reader signal.

52. A transponder as claimed in claim 48, characterised in that the acceptance instruction uses the same modulation of the reader signal as the mute instruction.

53. A transponder as claimed in claim 48, characterised in that the acceptance modulation has a different duration to the mute modulation.

54. A transponder as claimed in claim 48, characterised in that the mute instruction comprises a short interruption in the reader signal and the acceptance instruction comprises a longer interruption in the reader signal.

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55. A transponder as claimed in any of claims 45 to 54, characterised in that the transponder includes a random wait timer which triggers the transmission of the transponder signal after a random wait cycle has been completed.

56. A transponder as claimed in claim 55, characterised in that if a transponder receives a mute instruction before it has begun transmitting a transponder signal, the random wait cycle of said transponder is halted.

57. A transponder as claimed in claim 56, characterised in that the random wait cycle of the said transponder is restarted by an acceptance instruction issued by the reader.

58. A transponder as claimed in claim 56, characterised in that the random wait cycle of the said transponder is reset by an acceptance instruction issued by the reader.

59. A transponder as claimed in claim 56, characterised in that the random wait cycle of the said transponder is reset after a predetermined time of time.

60. A transponder as claimed in claim 55, characterised in that if a transponder receives a mute instruction before it has begun transmitting a transponder signal, the transponder is inhibited from transmitting the transponder signal at the end of the random wait cycle.

61 A transponder as claimed in claim 45, characterised in that the controlling transponder is permanently disabled by a disabling instruction from the reader after the controlling transponder signal has been successfully received by the reader.

62. A transponder as claimed in claim 45, characterised in that the controlling transponder is disabled for a predetermined period of time after the disabling instruction is issued.

63. A transponder as claimed in claim 45, characterised in that the controlling transponder is disabled by the disabling instruction until it is reset.

64. A transponder as claimed in claims 45 or 47, characterised in that the transponder includes local timing means.

65. A transponder as claimed in claim 64, as dependent on claim 47, characterised in that the reader synchronises the acceptance instruction with the local timing means of the controlling transponder.



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66. A transponder as claimed in any one of claims 45 to 65, characterised in that the circuitry on the transponder is in the form of an integrated circuit having read/write capabilities

67. A transponder as claimed in claim 66, characterised in that instructions sent from the reader to the transponder include coded instructions incorporated in the mute instructions

68. A transponder as claimed in claim 66 or claim 67, when dependent on claim 47, characterised in that instructions sent from the reader to the transponder include coded instructions incorporated in the acceptance instruction.

69. A transponder as claimed in claim 67 or 68, characterised in that the mute and/or acceptance instructions are in the form of interruptions in the reader signal, the coded instructions being present in the gaps in the reader signal defined by those interruptions.

70. A transponder as claimed in claim 50, characterised in that each transponder includes a gap length detector circuit for determining the length of the interruption in the reader signal.

71. A transponder as claimed in claim 70, characterised in that the gap length detector circuit detects a mute instruction and pauses the random wait cycle.

72. A transponder as claimed in claim 71, characterised in that the gap length detector circuit detects an acceptance instruction and enables the random wait cycle to resume.

73. An integrated circuit for use in a transponder, comprising receiver means for receiving a reader signal, transmission means for transmitting a transponder signal containing data which identifies the transponder whereby in a set of transponders, two or more transponders may transmit their transponder response signals in response to receiving the reader signal, characterised in that there is provided control means, whereby on recognising a mute instruction in the reader signal, all active transponders in the set but one are muted and control is passed to said one transponder, without the need for a specifically timed acknowledgement to the said controlling transponder.

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74. An integrated circuit as claimed in claim 73, characterised in that the mute instruction from the reader comprises a modulation of the reader signal and the integrated circuit has detection means for recognising the modulation.

75. An integrated circuit as claimed in claim 74, characterised in that the control means of the circuit can detect an acceptance instruction in the reader signal after the controlling transponder signal has been successfully received by the reader.

76. An integrated circuit as claimed in claim 75, characterised in that the acceptance instruction comprises a modulation of the reader signal.

77. An integrated circuit as claimed in claims 74, characterised in that the modulation comprises a total interruption of the reader signal.

78. An integrated circuit as claimed in claims 74, characterised in that the modulation comprises a partial interruption of the reader signal.

79. An integrated circuit as claimed in claims 46 or 48, characterised in that the instruction is signal transmitted independently from the reader signal.

80. An integrated circuit as claimed in claim 75 or 76, characterised in that the mute instruction comprises a short interruption in the reader signal and the acceptance instruction comprises a longer interruption in the reader signal.

81. An integrated circuit as claimed in any of claims 73 to 80, characterised in that the circuit includes a random wait timer which triggers the transmission of the transponder signal after a random wait cycle has been completed.

82. An integrated circuit as claimed in claim 81, characterised in that if the circuit receives a mute instruction before it has begun transmitting a transponder signal, the random wait cycle of said transponder is halted.

83. An integrated circuit as claimed in claim 81, characterised in that the random wait cycle of the said transponder is restarted by an acceptance instruction issued by the reader.

84. An integrated circuit as claimed in claim 81, characterised in that the random wait cycle of the said transponder is reset by an acceptance instruction issued by the reader.

85. An integrated circuit as claimed in claim 81, characterised in that the random wait cycle of the said transponder is reset after a predetermined time of time.

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86. An integrated circuit as claimed in claim 82, characterised in that if a transponder receives a mute instruction before it has begun transmitting a transponder signal, the transponder is inhibited by the circuit from transmitting the transponder signal at the end of the random wait cycle.

87. An integrated circuit as claimed in claim 73, characterised in that the controlling transponder is permanently disabled by a disabling instruction from the reader after the controlling transponder signal has been successfully received by the reader.

88. An integrated circuit as claimed in claim 73, characterised in that the controlling transponder is disabled for a predetermined period of time after the disabling instruction is issued.

89. An integrated circuit as claimed in claim 73, characterised in that the controlling transponder is disabled by the disabling instruction until it is reset.

90. An integrated circuit as claimed in claims 73 to 89, characterised in that the circuit includes local timing means.

91. An integrated circuit as claimed in any one of claims 73 to 90, characterised in that the integrated circuit has read/write capabilities

92. An integrated circuit as claimed in any of claims 73 to 91, characterised in that there is included a gap length detector circuit for determining the length of the interruption in the reader signal.

93. An integrated circuit as claimed in claim 92, characterised in that the gap length detector circuit detects a mute instruction and pauses the random wait cycle.

94. An integrated circuit as claimed in claim 92, characterised in that the gap length detector circuit detects an acceptance instruction and enables the random wait cycle to resume.

95. A reader comprising transmitter means for transmitting an interrogation signal to at least one transponder at a time when at least one other transponder may transmit in response to the interrogation signal and receiver means for receiving a response signal from a transponder, characterised in that on recognising a transponder signal from the transponder the reader immediately issues a mute instruction, muting all other active transponders, and passing control to said transponder, without the need for a specifically timed acknowledgement to the said controlling transponder.



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96. A reader as claimed in claim 95, characterised in that the mute instruction comprises a modulation of the reader signal.

97. A reader as claimed in claim 95, characterised in that the reader issues an acceptance instruction after the controlling transponder signal has been successfully received by the reader.

98. A reader as claimed in claim 97, characterised in that the acceptance instruction comprises a modulation of the reader signal.

99. A reader as claimed in claims 93 to 96, characterised in that the modulation comprises a total interruption of the reader signal.

100. A reader as claimed in claims 93 to 96, characterised in that the modulation comprises a partial interruption of the reader signal.

101. A reader as claimed in claims 93 to 96, characterised in that the instruction is signal transmitted independently from the main reader signal.

102. A reader as claimed in claim 97, characterised in that acceptance instruction uses the same modulation of the reader signal as the mute instruction.

103. A reader as claimed in claim 97, characterised in that the acceptance modulation has a different duration to the mute modulation.

104. A reader as claimed in claim 97, characterised in that the mute instruction comprises a short interruption in the reader signal and the acceptance instruction comprises a longer interruption in the reader signal.

105. A reader as claimed in any one of claims 92 to 104, characterised in that the reader transmits the mute instruction as soon as the reader recognises, or there is a high probability that the reader has recognised, a valid signal from the transponder.

106. A reader as claimed in any one of claims 93 to 106, characterised in that the reader is adapted to distinguish the first few distinctive pulses in the signal from the transponder as being a signal from a transponder.



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