Title: WIRELESS COMMUNICATION DEVICE FOR COMMUNICATION BETWEEN MULTI-TAGS AND READERS AND METHOD THEREOF

Abstract: The present invention relates to a wireless communication device, so called RF shower system, applied to a RFID system for low-powered reader-tag communication, more specifically to a wireless communication device, so called RFID system for multi-readers-tags communication, wherein, a RFID system of which the plurality of readers exits simultaneously, which is provided with a predetermined communication means for arbitrating communication order of readers to prevent readers from communication conflict between the readers, so that to let the communication smoothly between a plurality of reader and a plurality of tags.
Description

WIRELESS COMMUNICATION DEVICE FOR COMMUNICATION BETWEEN MULTI-TAGS AND READERS AND METHOD THEREOF

Technical Field

[1] The present invention relates to a wireless communication device which is actually a RF shower system and which is applicable to a RFID system for reader-tag communication, and the control method of the wireless communication device, and more particularly, to a RF shower system for multi-reader-tag communication, and the control method of the wireless communication device, wherein, in a wireless communication environment of which the plurality of readers read or write an information from or into the plurality of tags, to let the passive tag receive the forwarded data by amplifying weak signal from low-powered reader and forwarding the amplified signal to passive tag in a specific region, or to enlarge reading and writing distance between readers and tags by storing tag information read from the plurality of the passive tags which exist in a certain area of RF radiation area, and providing a tag information to the wireless communication device when a request from one of reader happens, a wireless communication device(RF shower system) for multi-readers-tags which is provided with a predetermined communication means for arbitrating communication order of readers to prevent readers from communication confliction in case that a plurality of readers exist simultaneously, so that to let the communication smoothly between a plurality of reader and a plurality of tags.

Background Art

[2] In general, RFID(Radio Frequency Identification) system can recognize and trace an animal or human body who a tag attached by reading or writing an information from or into the tag which stores unique identification information using RF signal in non-contact manner. The RFID system is comprised of a plurality of tags or so-called transponder adhered to an animal or a human body with a unique identification information, and RFID reader or so-called interrogator for reading or writing information from or into the tags or transponder.

[3] Fig. 1 shows an example of general communication process between reader and tags in conventional RFID system. The tag 20 in the conventional RFID system of FIG. 1 is a kind of passive tag 1 which does not include any battery within body itself. Therefore, for achieving of communication between reader 10 and tag 20, the passive tag 20 should be activated in advance. For this activation purpose, the reader 10 transmit Start Continuous Wave(now it will be called with Start CW hereafter) of
specific frequency band, query signal, and End Continuous Wave (now it will be called with End CW hereafter). The power will be generated by the Start CW and the End CW during backscattered modulation of tag response. Therefore, the transmitting processes of the Start CW and the End CW can be called with power transmitting process. The passive tag 20 is activated by the power transmitting process from the reader 10. And thus the activated passive tag 20 transmit the unique information stored itself on End CW period to the reader 10 during back scattered modulation. As described above, the communication between reader 10 and tag 20 is performed during wireless power transmitting process simultaneously in the conventional RFID system.

Meanwhile, the RFID reader 10 could be connected to a network 40, such as computer, and the network 40 control the RFID reader 10 to read or store or analyze the information written in the tag using a predetermined application program. Even though Fig. 1 denotes an example which uses amplitude modulated (ASK) signal, the meaning will not be changed when it uses phase modulated (PSK) signal.

As already known, there are two kind of method for transmitting power in a wireless manner by the RFID reader. The one is magnetic field combination method which uses multi-wound coils formed in the reader and tags. And the other is RF-band communication method which uses electro-magnetic waves of high frequency band between the reader and tags. However, the magnetic field combination method which uses multi-wound coils is used only for limited use such as access control or bus card because of its short recognition distance. Thus the RF-band communication method of which recognition distance could be extended over 10 meter, is mainly used. In this RF-band communication method, the distance of communication could be more extended by increasing the output of RF-band communication signal transmitted from the reader in theory. However, as reader transmission output increases, frequency interference between adjacent readers or the wireless communication could be happened. Further to this, for radiating of RF band’s communication signal, the reader size should be increased and consumption of battery will also be increased, and thus it has a disadvantage that the retail price should be high. This advantage will be a quite big obstacle to apply a RFID reader to personal mobile terminal.

To solve this problem, Korean Patent Application Number 05-1 1236 entitled Low-powered intelligent RFID system for reader-tag communication and the method thereof, invented by the inventors of this application, and Korean Patent Application Number 05-1 1236 entitled An extensive RFID system for reader-tag communication and method thereof, invented by the inventors of this application disclose that a wireless communication device (RF shower system) which include a predetermined communication means to communicate with a reader. The overall technical idea for the above two patent application are incorporated to this specification as reference.
However, as shown in Fig. 2, the wireless communication device uses a local oscillator when it communicates with a reader without synchronizing with carrier frequency of the reader. Therefore, because a response transmission reader's will be happened as soon as receipt of End CW, it has a problem that interference could be happened if the frequency and phase does not synchronize accurately between the carrier signal of the reader and the response transmission of the wireless communication device.

Also, for using a communication protocol as it uses during communication between the reader 10 and the tag 10 without using of separate protocol, the wireless communication device must be based on the backscattered modulation as a tag response of Fig. 1 using End CW of the reader. However, as because the communication distance is dependent on output power of the reader, so it could be unable to communicate using a desired output power level, therefore, to apply the backscattered modulation, the communication distance will be restricted within short area. On the other hand, the backscattered signal should be amplified to enlarge the communication distance, however, it has problems that oscillation could be happened due to the interference described above, or communication error could be happened due to that as the modulated transmission signal can influx to a receiving portion even in the case the oscillation does not happened.

Also, to maintain the level of the amplified signal to a certain desired level in the attenuator of Fig. 2 regardless of the level of input signal, the level of the input signal should be justified. However, in case that the query signal has been amplitude modulated, the level changes according to point of time to detect the level of query signal input. Therefore, maintaining of the output signal level to a certain predetermined level is not easy.

Disclosure of Invention

Technical Problem

The present invention will focus to solve the problems of the above-described conventional RFID system, and to let communication between a plurality of readers and tags be smooth. The main objective of the present invention is to provide a wireless communication device, when a plurality of low-powered readers exist in a certain area, of which to generate a response signal with same frequency and phase and thus to communicate with the low-powered reader, even though is does not receive synchronization signal from the low-powered reader, so that any confliction will not be happened between the readers by arbitrating the communication order of readers, even it does not use a separate protocol.

Also, The present invention will provide a wireless communication device of which
to read and store in advance from all of tags exist in a certain size of radiation area, so that to provide the stored tag information to a reader which permitted to communicate with the tag when any request from the reader is, or to let the reader read the response signal of the tag by recognizing the amplified reader signal and responding to the reader.

Also, the another objective of the present invention is to provide a wireless communication device to maintain the output signal level of the wireless communication device to a desired fixed level (so called, Auto Gain Control (AGC)) regardless of the level of input signal, by detecting of the level of Start CW for the query signal from the reader, so that to maintain the response signal level of the wireless communication device or the output signal level of the wireless communication device to a desired fixed level, even though the mobile reader moves.

And, therefore, a wireless communication device (so called, RF shower system) is provided to be able to enlarge the distance of reading and writing between readers and tags or between the readers and the wireless communication device.

Therefore, the present invention provide a wireless communication device to decide whether to mediate order of communication in response to the reader's query signal or to amplify the weak signal from the reader and transmit the amplified signal to the tag in case that it is applied to the RFID system as disclosed in Korean Patent Application 06-69488, alternatively to read and store the tag information in a certain size of area in advance and provide stored tag information to the reader when the reader which permitted to communicate with request for the same in case that it is applied to the intelligent RFID system as disclosed in Korean Patent Application 05-1 1236, and provide a control method thereof.

Also, present invention provide a wireless communication device to store carrier frequency of Start CW of reader's query signal for a certain period, and to synchronize frequency and phase accurately, so that to prevent from interfering with End CW of query signals by using the stored carrier frequency during responding period, and control method thereof, and a frequency/phase synchronizing control device which preferably applied to the said wireless communication device and control method thereof.

Further, the present invention provide a wireless communication device for controlling of internal gain automatically to maintain the level of the amplified signal to a certain desired level regularly regardless level of input by detecting Start CW of reader's query signal which is amplitude modulated and input to the wireless communication device, and the control method thereof.

Technical Solution
According to an aspect of the present invention, there is provided a wireless communication device of an extensive RFID system for low-powered reader-tag communication, the wireless communication device for multi-readers-tags communication comprising:

a circulator for forwarding a reader signal of RF band received from a transceiver antenna to the first band-limited filter so that transmitting an arbitration responding signal of RF band communication channel Fx received from a first high-powered amplifier to the reader through the transceiver antenna;

a first low-noise amplifier for amplifying reader signal forwarded from the circulator;

a first frequency converter for converting reader signal amplified by the first low-noise amplifier to intermediate frequency;

a intermediate frequency divider for splitting and transmitting the reader signal of intermediate frequency converted by the first frequency converter to a arbitration communication channel Fx and a shower communication channel F \sim F^N I

a second SAW filter and a third SAW filter for band-passing the arbitration communication channel Fx or the shower communication channel F \sim F^N I among the input signal of intermediate frequency signals passed through the intermediate frequency divider;

a first and a second A/D converter for converting intermediate frequency of reader's arbitration signal or shower's query signal passed through the second SAW filter and the third SAW filter to digital signal;

a system controller for clarifying digital reader signal input through the first and a second A/D converter, analyzing of arbitrating signal in case of arbitration query signal, checking whether the reader is at communication through the Shower channel or not and whether any conflicting is or not between readers by analyzing the arbitration signal in case of Arbitration query signal and generating appropriate response signal of FMO or Miller including no response, Non-ACKnowledgement, and AC-Knowledgement for the reader tried to communicate with a tag, storing Start CW signal of reader for synchronizing frequency and phase of the Start CW signal with End CW signal during responding period, synchronizing frequency and phase of Start CW signal of reader and End CW signal using stored Start CW signal, modulating response signal using the synchronized signal as carrier frequency of response signal, forwarding shower channel signal after sending ACK response to Arbitration channel in case of Shower channel signal, and detecting input level of signals and generating control signal for output level;

a first D/A converter for converting the modulated Arbitration digital response signal of FMO or Miller generated in the system controller into analog signal of in-
termediate frequency;

[26] a forth SAW filter for bypassing response signal of intermediate frequency received from the first D/A converter;

[27] a forth frequency converter for converting the response signal of intermediate frequency passed though the forth SAW filter into response signal of RF band;

[28] a forth band limited-filter for band-passing a desired band signal among the signal received from the forth frequency converter;

[29] a forth-second amplifier for amplifying output signal of the forth band-limited filter;

[30] a first attenuator for adjusting the level of the amplified signal as control signal of the system controller appropriately;

[31] a first high-powered amplifier for amplifying output signal of the first attenuator for sending the RF-band response signal to the reader through a circulator and a transceiver antenna;

[32] a second D/A converter for converting Shower channel signal passed through the system controller into analog signal of intermediate frequency;

[33] a fifth SAW filter for by-passing reader's query signal received form the second D/A converter;

[34] a fifth frequency converter for converting the reader's query signal of intermediate frequency passed through the fifth SAW filter into a response signal of RF band;

[35] a band-limited filter for by-passing a desired band among the signal received from the fifth frequency converter;

[36] a fifth-second amplifier for amplifying output signal of the fifth band-limited filter;

[37] a second attenuator for adjusting the level of the amplified signal as control signal of the system controller appropriately; and

[38] a second high-powered amplifier for amplifying Shower channel output signal passed through the second attenuator to send amplified signal to the tag through the transceiver antenna.

Advantageous Effects

As described above, the wireless communication device according to the present invention generates a response signal having same frequency and phase with that of query signal without receiving of any synchronizing signal from a low-powered reader so that generated response signal does not interfere with reader and any confliction does not happen between readers. Therefore, according to the present confliction between a plurality of readers which is noted serious problem in RFID system, could be resolved.

Also, when the wireless communication device according to the present invention is adopted to an extensive communication system, the wireless communication device
can amplify a query signal from reader which permitted to communicate with the tag, and so it can send the amplified signal to a plurality of tags exist in a certain size of radiation area with a appropriate output level.

Also, when the wireless communication device according to the present invention is adopted to an intelligent wireless communication system, the wireless communication device can read and store in advance from all of tags exist in a certain size of radiation area, so that send the stored tag-information to a low-powered reader in response to the query signal from a reader with a appropriate output level, and thus the problem of limited recognition distance will be resolved. According to the present invention, it can enlarge a recognition distance between readers and tags without increasing of output power, so that it will be possible to realize a reader with low power consumption, minimized size, and low-cost production.

Brief Description of the Drawings

FIG. 1 is a schematic diagram shown a basic operation of conventional RFID system.

FIG. 2 is a schematic diagram shown exemplary detailed structure for conventional extensive wireless communication device, so called RF Shower System.

FIG. 3 is a schematic diagram shown a basic structure of conventional extensive RFID system for low-powered reader-tag communication.

FIG. 4 is a schematic diagram shown exemplary detailed structure for wireless communication device, so called RD Shower System according to the present invention.

FIG. 5 is block diagram shown detailed structure of the system controller of FIG. 4.

FIG. 6 is block diagram shown detailed structure of the carrier frequency/phase detecting portion of the system controller of FIG. 5.

FIG. 7 is a flow chart shown operation of RF Shower System of FIG. 4.

FIG. 8 is a flow chart shown detailed operation of the carrier frequency/phase detecting portion of FIG. 6.

FIG. 9 is a schematic diagram shown a basic structure of conventional intelligent RFID system for low-powered reader-tag communication.

FIG. 10 is a schematic diagram shown detailed structure of the wireless communication device for multi-tags-readers communication, so called RF Shower System, according to the present invention.

FIG. 11 is a flow chart shown operation of intelligent wireless communication device for multi-tags-readers communication according to the present invention.

FIG. 12 is a schematic diagram shown an exemplary method of frequency/phase detecting according to the present invention.

Best Mode for Carrying Out the Invention
And thus it will be embodied to a body of mobile terminal such as mobile phone or PDA, so that mobile communication terminal having a function of RFID reader could be provided.

The present invention will now be described more fully with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. FIG. 3 shows a basic structure of conventional extensive RFID system for low-powered reader-tag communication. As shown in FIG. 3, extensive RFID system is comprised of RFID reader 10, passive tag 20, wireless communication device (RF Shower System) 30, reader zone 101 for communication between the wireless communication device 30 and reader 10, tag zone 102 for transmitting of reader signal of the wireless communication device 3 and tag 20, and recognition zone 103 for receiving of the reader 10 a response signal during backscattered modulation. Wherein, reader zone 101, tag zone 102, recognition zone 103 denotes a physical region possible to communicate with reader 10, wireless communication device 30, and/or tag 20.

As shown, a plurality of reader 10 and a wireless communication device 30 communicates using an arbitrary communication channel Fx, and the wireless communication device 30 arbitrates the order of communication of readers, so that conflict doesn't happen between readers. At this time, the reader 10 forms reader zone 101 being communication region which can communicates with the wireless communication device 30. The communication with the wireless communication device 30 for arbitrating the order of communication between a plurality of readers 10 and tags 20 could be performed by allocating an arbitrary communication channel Fx via defining of a separate protocol, also by using a channel to be used for communication between reader 101 and tag 102 and extended protocol. And thus the scope of the present invention will not limited to use of an arbitrary communication channel Fx.

Also, if any response signal or any information from the wireless communication device could be received, the reader 10 decide the system situation as a system of which any wireless communication does not exist, sole communication of reader 10 for recognizing of tag 20 could be performed. Here, a method of a plurality of reader 10's deciding of existence of the wireless communication device could be performed using an arbitrary communication channel Fx, or the wireless communication device transmits Beacon signal continuously, and the plurality of reader 10 can verifies the existence of the wireless communication device using Beacon signal without communicating with the wireless communication device 30.

As described above, in case of extensive RFID system including a wireless communication device 30, the reader 10 sends a query signal to the passive tag 20 for reading and writing according to the arbitrated order of the wireless communication
device 30, and the wireless communication device 30 amplifies the query signal from the reader 10, and sends the amplified signal to tag zone 102 randomly allocated. Then, tag 20 in the tag zone 102 is activated using the signal from the wireless communication device 30, and a tag zone 102 of which the query signal from the reader 10 could be recognized is formed. Therefore, the tag 20 recognize the signal received from the wireless communication device as reader signal, and is activated using received power and recognize the command of the reader 10. And then the tag 20 sends its unique information to the reader 10 during backscattered modulation. The reader 10 in considerably long distance can receive the response signal from the tag 20, and reads the unique information of tag 20 or writes a specific information into the tag 20, so that the specific information could be written into the tag 20.

As described above, the extensive RFID system amplifies weak signal from the RFID reader 10, and send amplified signal of high level to the tag so that the distance of reading and writing could be enlarged and the confliction between readers could be prevented also through the communication between a plurality of reader 10 and the wireless communication device 30.

FIG. 4 is a block diagram shown a detailed structure of the wireless communication device according to the present invention for extensive RFID system for multi-tags-readers communication. As shown in FIG. 4, preferably, the communication channel Fx used to make up the communication order of readers in multi-readers environment should be separated with channel F1 - FN for communication between readers-tags, so that the possibility that the communication could be interfered between readers and tags when the reader transmits an Arbitration query signal, could be eliminated.

As shown in FIG. 4, the wireless communication device, so called RF Shower System, comprises a transceiver antenna 200 for transmitting and receiving signals to communicate with reader; a circulator 201 for forwarding a reader signal of RF band received from a transceiver antenna 200 to the first band-limited filter 202 so that transmitting an arbitration responding signal of RF band communication channel Fx received from a first high-powered amplifier 229 to the reader through the transceiver antenna 200; a first band-limited filter 202 for band-passing reader signal among input signal without interfering of another bands; a first low-noise amplifier 203 for amplifying reader signal passed through the first band-limited filter 202; a first frequency converter 204 for converting reader signal amplified by the first low-noise amplifier 203 to intermediate frequency; and a intermediate frequency divider 205 for splitting and transmitting the reader signal of intermediate frequency converted by the first frequency converter 204 to an arbitration communication channel Fx and a shower communication channel $F_1 \sim F_N$. 

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Also, the wireless communication device comprises: a second amplifier 206 for amplifying intermediate frequency passed through the intermediate frequency divider 205; a second SAW filter 207 for by-passing an Arbitration communication F among the input signal of reader's intermediate frequency input signals passed through the second amplifier 206; a first A/D converter 208 for converting intermediate frequency of reader's Arbitration query signal passed through the second SAW filter 207 into digital signal.

Also, the wireless communication device has a third amplifier 209 for amplifying intermediate frequency passed through the intermediate frequency divider 205; a third SAW filter 210 for band-passing the shower communication channel \( F_x \) among the input signal of reader's intermediate frequency passed through the third amplifier 209; a second A/D converter 211 for converting intermediate frequency of shower's query signal passed through the third SAW filter 210 into digital signal.

Also, the wireless communication device has a system controller 300 for clarifying digital reader signal input through the first A/D converter 208 and a second A/D converter 211, analyzing of arbitrating signal in case of arbitration query signal, checking whether the reader is at communication through the Shower channel or not and whether any conflicting is or not between readers by analyzing the arbitration signal in case of Arbitration query signal and generating appropriate response signal of FM0(Bi-phase space) or Miller including no response, Non-Acknowledgement, and Acknowledgement for the reader tried to communicate with a tag, storing Start CW signal of reader for synchronizing frequency and phase of the Start CW signal with End CW signal during responding period, synchronizing frequency and phase of Start CW signal of reader and End CW signal using stored Start CW signal, modulating response signal using the synchronized signal as carrier frequency of response signal, forwarding shower channel signal after sending ACK response to Arbitration channel in case of Shower channel signal, and detecting input level of signals and generating control signal for output level.

Also, the wireless communication device has a first D/A converter 222 for converting the modulated Arbitration digital response signal of FM0 or Miller generated in the system controller 300 into analog signal of intermediate frequency; a forth-first amplifier 223 for amplifying the response signal of intermediate frequency received from the first D/A converter 222; a forth SAW filter 224 for bypassing signal of desired band among the bands of amplified response signal of intermediate frequency received from the first D/A converter 222; a forth frequency converter 225 for converting the response signal of intermediate frequency passed though the forth SAW filter 224 into response signal of RF band; a forth band limited-filter 226 for band-passing a desired band signal among the frequency bands of the signal received.
from the forth frequency converter 225; a forth-second amplifier 227 for amplifying output signal of the forth band-limited filter 226; a first attenuator 228 for adjusting the level of the amplified signal as control signal of the system controller 300 appropriately; and a first high-powered amplifier 229 for amplifying output signal of the first attenuator 228 for sending the RF-band response signal to the reader through a circulator 201 and a transceiver antenna 200.

Further, the wireless communication device has a second D/A converter 212 for converting Shower channel signal passed through the system controller 300 into analog signal of intermediate frequency; a fifth-first amplifier 213 for amplifying reader query signal of intermediate frequency received from the second D/A converter 211; a fifth SAW filter 214 for bypassing signal of desired band among the frequency bands of amplified response signal; a fifth frequency converter 215 for converting the reader's query signal of intermediate frequency passed through the fifth SAW filter 214 into a response signal of RF band; a fifth band-limited filter 216 for by-passing a desired band among the signal received from the fifth frequency converter 225; a fifth-second amplifier 217 for amplifying output signal of the fifth band-limited filter 216; a second attenuator 218 for adjusting the level of the amplified signal as control signal of the system controller 300 appropriately; and a second high-powered amplifier 219 for amplifying Shower channel output signal passed through the second attenuator 218 to send amplified signal to the tag through the transceiver antenna 220.

Here, to handle Arbitration query signal, preferably, the system controller 300 includes an Arbitration signal demodulator 301 for detecting the level of input signal, deciding whether the detected level corresponds to 0 or 1 in comparison to threshold value, and so that demodulating base-band signal of query signal; a CW interval detector 302 for detecting a interval of which 1 continues over predetermined length in demodulated signal, and decide the same interval as Start CW interval; a CW interval level detector 303 for detecting the level of CW interval input from detected CW interval; an output signal level calculator 304 for calculating difference value to set level of response signal with a predetermined level for the detected input CW level; a carrier frequency/phase manager 305 for detecting and storing a reader's transmitting frequency to use the detected transmitting frequency as a carrier frequency and circulating repeatedly of stored frequency to maintain synchronized phase; a CW level controller 306 for controlling the level of stored CW transmitting frequency using calculated difference value; a query signal handling and response signal generating portion 308 for clarifying reader's query signal of demodulated base-band by the Arbitration signal demodulator 301, checking whether the reader is in communication via Shower channel, and generating appropriate digital response signal of FMO or Miller including no response, Non-ACKnowledgement, and ACKnowledgement for the
reader tried to communicate with a tag; and a response signal modulator 307 for modulating carrier frequency level adjusted to response of base-band generated by the query signal handling and response signal generating portion 308.

[68] Here, for synchronizing with reader’s frequency and phase accurately using stored Start CW, the carrier frequency/phase manager 305 circulate repeatedly specific interval of Start CW not to create discontinuity of phase through start point to end point. For the operation of the above-described synchronization, as shown in FIG. 6, the carrier frequency/phase manager 305 is comprised of a CW storing portion 305-1 for storing Start CW interval of reader carrier; a circulating start point searching portion 305-2 for searching a start point of interval among whole of stored CW interval to circulate repeatedly specific interval of Start CW for synchronizing in start point searching and settlement interval; a circulation start point and end point searching portion 305-3 for finding a reference value, searching to decide an end point by comparing reference value in an end point interval, and storing of the decided end point and completing of searching process; a phase control portion 305-4 for receiving memory address information of start point and end point from the circulation start point and end point searching portion 305-3 and controlling of timing not to happen of phase difference in values in the memory address when it circulates; and a CW circulating portion 305-5 for circulating repeatedly values in memory addresses from the start address to the end address of which phase controlled, outputting transmitting CW for modulation of response signal as soon as it received a start time information of response signal the query signal handling and response signal generating portion 308, and completing output of carrier CW and circulating as soon as it receives a completing time information of response signal from the query signal handling and response signal generating portion 308.

[69] Also, as shown in FIG. 5, to handle a query signal of shower channel, the system controller 300 is comprised of a shower signal demodulating portion 309 for detecting the level of input signal, and demodulating the query signal by comparing detected input level with a predetermined threshold value to decide 0 or 1; a CW interval detecting portion 310 for detecting an interval which 1 continues for a certain period or more among the demodulated signal, and deciding Start CW interval using the detected interval; a CW interval level detecting portion 311 for detecting level of CW interval input from the detected CW interval; an output signal level calculator 312 for calculating a difference value to control output level of shower channel output signal for adjusting output level to a predetermined level for shower channel signal, and outputting an attenuator control signal; a query signal manipulation and response signal generating portion 308 for receiving reader query signal in digital format from the shower signal demodulating portion 309, and controlling the system controller to
modulate the query signal as it is only for the query signal input after generating of ACK response in response to the arbitration query signal; and a shower signal modulating portion 313 for modulating shower channel signal in digital format as it is according to the control signal from the query signal manipulation and response signal generating portion 308.

Now the operation process of the wireless communication device 30 for extensive wireless RFID system according to an embodiment of the present invention will be described herein after, with reference to the FIG. 7.

In extensive RFID system, input signal forwarding path for the wireless communication device 30 will be configured according to the channel of query signal transmitted from the reader 10. The signal flows through the arbitration communication channel are as follows. If the reader 10 transmits arbitration query signal to the wireless communication device 30 for occupying of a communication channel(S100) to communicate with tag 20, transceiver antenna 200 receives the query signal(S200). The query signal is amplified through the circulator 201, the first band-limited filter 202, and the first low-noised amplifier 203. The amplified query signal is converted to intermediate frequency in the first frequency converter 204. Then desired frequency band for the arbitration communication channel is filter-out through the frequency divider 205, the second amplifier 206, and the second SAW filter(S300). The filtered signal is converted into digital signal in the first A/D converter 208, and converted digital signal is supplied to the system controller 300.

And then, the system controller 300 demodulates the digital arbitration query signal received(S400), so that changes it into base-band signal. The query signal handling and response signal generating portion 308 analyse and checking the transmitted information from the reader, and identifying whether any confliction between readers is or not in current arbitration communication channel(S500), then ignore the query signal to handle this situation as no answer if confliction happened. On the other hand, if no confliction did not happened, the query signal handling and response signal generating portion 308 generates a NACK signal of base-band when the reader admitted to perform communication previously communicates with the tag through the shower channel, otherwise, generates a ACK signal when shower channel is not activated(S600), and then modulates the generated signal as arbitration response signal(S1 100). The modulated response signal in digital format is converted into analog signal by the first D/A converter 222. The arbitration response signal is filter-out through the forth-first amplifier 223, the forth SAW filter 224, and the forth SAW filter 224(S 1200). The filtered arbitration response signal is converted into RF frequency band signal by the forth frequency converter 225, and the level is adjusted to an appropriate desired level through the for the band-limited filter 226, the forth-
second amplifier 227, and the first attenuator 228 (S1300). The resultant signal is transmitted to the reader through the first high-powered amplifier 229, circulator 201, and transceiver antenna 200 (S1400). The control signal for adjusting output level to appropriate level in the first attenuator 228 is generated by calculating a difference value (S800) between the input signal level detected (S700) at start CW interval of query signal and the predetermined output level of response signal.

Amso, the Start CW of reader arbitration query signal is stored in advance and the same signal is used for the carrier frequency. The carrier frequency is used to modulate the arbitration response signal of base-band transmitted from the wireless communication device in end CW period. For this, the carrier frequency/phase detector 305 detects carrier frequency/phase of the reader query signal, and circulates repeatedly the stored frequency for maintaining synchronized phase (S900). Because detected level of reader carrier frequency will be changed according to the level of reader signal input, CW level controller 306 control the detected level of CW carrier frequency for maintaining this level (S1000). Control signal for adjusting stored CW level is generated by the same control method as described with refer to the first attenuator 228.

Now, the operation process of carrier frequency/phase detecting portion 305 for the wireless communication device 30 according to the present invention will be described with refer to FIG. 5, 8, and 12. Firstly, CW interval detecting portion checks whether the detected CW interval detected during CW checking period is start CW or end CW (S901), and CW storing portion 305-1 stores carrier CW only for the start CW interval of reader query signal (S902). Continuity of phase between storing start point and end point on time basis should be guaranteed for generating carrier for response signal which has same frequency and phase with that of reader's carrier frequency among CW data stored in digital format. For this, the circulating start point searching portion 305-2 searches a peak value among CW values of digital format in pre-specified start point searched/decided interval (S903), and then refers the address of memory which has been stored the value of next clock (S904) of the peak value so that the address will be used as a start point to maintain carrier frequency and phase of reader query signal. Meanwhile, the storing of CW should be complete as soon as find out the end point of searched/decided interval. For this, the circulation start point and end point searching portion 305-3 searches a peak value among CW values of digital format in pre-specified start point searched/decided interval (S905), and searches values greater or equal to this value during a pre-specified end point deciding interval (S906). If a value greater or equal to this value has been found (S907), the storing of CW is completing as soon as find out the value and memory address stored the value will be used as an end address of circulating (S908). As the reader query signals are inputting
continuously, the frequencies and phases generated signals only by circulating values sequentially stored between the start address and the end address repeatedly simply will not be same with carrier frequencies and phases of the reader query signals. Therefore, the phase control portion 305-4 remove a phase difference of values generated temporally between start point and end point of circulating interval(S909), and synchronise continuously the frequencies and phases of generated signals with those of reader carrier by circulating values stored addresses between start address and end address repeatedly(S910). Then, the frequencies phase-synchronised with carrier frequencies of reader 10 by the above-described processes are used as carries frequencies of response signal generated by the query signal handling and response signal generating portion 308. With this, it will now possible to protect interference between frequencies of response signal of the wireless communication device 30 and frequencies of reader 10. As start point and end point could be find out through various another methods, the searching a peak value among CW values of digital format in pre-specified start point searched/decided interval for finding out start point and end point for circulation of stored CW above-described is only for exemplary and thus the scope of the present invention will not be limited to this specific embodiment.

Referring to FIG. 4 and FIG. 7, when the communication for arbitrating communication order between a plurality of readers 10 and a wireless communication device 30 through the arbitration communication channel Fx has been completed, a communication channel will be allocated to the reader 10. Now, the reader 10 transmits query signal for reading and writing of tag 20's information through the shower channel(S100). The wireless communication device 30 receives the query signal of reader through the transceiver antenna 200. The query signal is amplified through the circulator 201, the first band-limited filter 202, and the first low-noised amplifier 203. The amplified query signal is converted to intermediate frequency in the first frequency converter 204. Then desired frequency band for the shower channel is filter-out through the frequency divider 205, the third amplifier 209, and the third SAW filter(S300). The filtered signal is converted into digital signal in the second A/D converter 211, and converted digital signal is supplied to the system controller 300.

Now referring to FIG. 7, the system controller 300 demodulates the query signal of digital shower channel(S1500) to make base-band signal, then a shower signal modulating portion 313 modulates the shower query signal(S1600) only received after the query signal handling and response signal generating portion 308 sends ACK to the reader through the arbitration communication. At this moment, whenever the confliction of reader by a shower channel signal from the reader of which communication has not been not admitted is detected, the query signal handling and response signal generating portion 308 can quit modulation process of the shower
signal modulating portion 313 at any time. The query signal in the modulated digital format is converted to analog signal by the second D/A converter 212. The query signal only of shower channel is filter out by the fifth SAW filter(S1700), and is converted to RF band frequency by the fifth frequency converter 215. The level of the converted signal is adjusted to appropriate level through the fifth band-limited filter 216, the fifth-second amplifier 217, and the second attenuator 218. Level adjusted signal is transmitted to a plurality of tags(S1900) through the first high-powered amplifier 219 and the transceiver antenna 220. At this moment, for adjusting the level of input signal detected in the Start CW interval of modulated shower channel query signal to a pre-specified output level of response signal, the control signal for adjusting its level to an appropriate level in the second attenuator 218 is generated by calculating a difference value(S800).

FIG. 9 show a basic structure of intelligent RFID system. As shown in FIG. 9, the wireless communication device 30 according to the present invention communicates with the passive tag 20 to read its unique information by the unified way of conventional reader-tag communication. Namely, the wireless communication device 30 radiates high-powered shower channel query signal F ~ F, and thus forms a certain size of radiation area Ra. The area of the radiation area is much wider than that of query region of RFID reader 10. A plurality of passive tags 20 receives power by receiving shower channel query signal, and communicates with the wireless communication device 30 with the tag information during the backscattered modulation processing. For this, the wireless communication device 30 can collect information from a plurality of passive tags 20. Namely, the radiation area Ra of the wireless communication device 30 will be an interrogation zone In. Therefore, information from all of passive tags 20 in wide area of radiation area Ra exits can be collected. The radiation area Ra of the wireless communication device 30 is a region defined though wireless communication between the wireless communication device 30 and tags 20. Therefore, the meaning of radiation Ra will vanished if the tag information should be input using a network or any other cable communication means by an administrator manually. Namely, because that this random region could be enlarged as occasion demands, so the scope of the present invention will not restricted to forming a radiation area by wireless communication.

Also, the wireless communication device 30 stores the information collected from a plurality of passive tags 20 as occasion demands periodically, and transmits stored information to the reader 10 when the reader requests for. Namely, the RFID reader 10 communicates with the wireless communication device 30 by the unified way of conventional reader-tag communication, and thus reads tag information stored in the wireless communication device 30. Also, the wireless communication device 30 sends
the tag information by carrying the response signal on the carrier frequency concurred with frequency and phase of reader only for the request of the reader of which communication is admitted using the arbitration communication channel among a plurality of tags. As all of the wireless communication device 30 and the reader 10 has high-output and low sensitivity, communication areas Ca could be formed with larger than radiation area Ra. Thus, the present invention has important an advantage that the RFID reader in intelligent RFID system can acquire information easily from the tag outside of the query region of the reader, namely, recognition region by reading the tag information using a conventional reader-tag communication method.

[79] FIG. 10 and FIG. 11 show a examples of detailed structure and operation flow respectively of the wireless communication device according to the present invention for an intelligent RFID system. It should be noted that the there are two parts of communication section. Thus, there are a communication section between the wireless communication device 30 and the tags 20 for reading out and storing the information of passive tags in the radiation region Ra, and a communication section between the reader 10 and the wireless communication device 30 and the tags 20 for determining the order of communication among the readers when a plurality of readers request for tag information, and transmitting stored tag information only to the reader of which the communication has been admitted.

[80] First of all, the reader has a structure similar as a conventional RFID reader for communication between the wireless communication device 30 and the tag 20. Thus, the communication section between the wireless communication device 30 and the tag 20 is comprised of a local oscillator 405 for oscillating a certain high band of frequency $F_1 \sim F_N$; a RF transmitter 403 for modulating, amplifying, and transmit the high frequency output from the local oscillator 405; a transceiver antenna for transmitting query signal from the RF transmitter 412 to the tag or for receiving a response signal during the backscattered modulation from the passive tag 20; a switch or so called a duplexer 402 for dividing transmitting high frequency signals into query signal and response signal; a RF receiver 404 for amplifying and modulating response signal of the tag passed out from the switch 402; and a system controller 300 for generating a query signal to extract a tag information, extracting and storing tag information from demodulated response signal of the tag. At this moment, it is more preferable that the communication between the wireless communication device 30 and the tag 20 for extracting the tag information is performed only when there is no reader or no communicating reader. Also, it is more preferable that, even in communication between the wireless communication device 30 and the tag 20, when any signal from a reader detected, the communication should be quit and the communication with the reader should be placed on higher priority.
Further, the structure of communication section between a plurality of readers 20 and a wireless communication device 30 is almost same with that of the wireless communication device of extensive RFID system as shown in FIG. 4, nothing but a path for transmitting of tag information has been added.

The additional structure for transmitting tag information to the reader by the wireless communication device 30 is comprised of: a third D/A converter 411 for converting tag information response FMO or Miller generated by the system controller 300 into intermediate frequency of analog signal; a sixth amplifier for amplifying intermediate frequency of response signal from the third D/A converter; a sixth SAW filter 413 for band-passing response signal band of shower channel among the amplified signals; a combiner 414 for combining arbitration channel response signal of intermediate frequency and shower channel response signal. As the signal after the combiner 414 is not divided with frequency, interference between the two signals does not occur. Meanwhile, arbitration communication of wireless communication device is described only for extensive wireless communication system, however, as the arbitration communication for transmitting tag information in intelligence RFID system will be performed using same way with the arbitration communication for extensive wireless communication system, therefore it will not described hereafter.

The above-described embodiments is only for exemplary explanations to explain more precisely, and thus the scope of the present invention does not limited to the above described embodiment, and various modification and variation could be made within the scope of the present invention defined by attached claims. While this invention has been particularly shown and described with reference to an exemplary embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

**Industrial Applicability**

The wireless communication device and the control method according to the present invention could be applied to industries using RFID components.
Claims

[1] A wireless communication device of an extensive RFID system for low-powered reader-tag communication, the wireless communication device for multi-readers-tags communication comprising:
ap circulator for forwarding a reader signal of RF band received from a transceiver antenna to the first band-limited filter so that transmitting an arbitration responding signal of RF band communication channel Fx received from a first high-powered amplifier to the reader through the transceiver antenna;
a first low-noise amplifier for amplifying reader signal forwarded from the circulator;
a first frequency converter for converting reader signal amplified by the first low-noise amplifier to intermediate frequency;
a intermediate frequency divider for splitting and transmitting the reader signal of intermediate frequency converted by the first frequency converter to a arbitration communication channel Fx and a shower communication channel F - F

N
a second SAW filter and a third SAW filter for band-passing the arbitration communication channel Fx or the shower communication channel F - F among the input signal of intermediate frequency signals passed through the intermediate frequency divider;
a first and a second A/D converter for converting intermediate frequency of reader's arbitration signal or shower's query signal passed through the second SAW filter and the third SAW filter to digital signal;
a system controller for clarifying digital reader signal input through the first and a second A/D converter, analyzing of arbitrating signal in case of arbitration query signal, checking whether the reader is at communication through the Shower channel or not and whether any conflicting is or not between readers by analyzing the arbitration signal in case of Arbitration query signal and generating appropriate response signal of FMO or Miller including no response, Non-ACKnowledge, and ACKnowledge for the reader tried to communicate with a tag, storing Start CW signal of reader for synchronizing frequency and phase of the Start CW signal with End CW signal during responding period, synchronizing frequency and phase of Start CW signal of reader and End CW signal using stored Start CW signal, modulating response signal using the synchronized signal as carrier frequency of response signal, forwarding shower channel signal after sending ACK response to Arbitration channel in case of Shower channel signal, and detecting input level of signals and generating control signal for
output level;
a first D/A converter for converting the modulated Arbitration digital response
signal of FMO or Miller generated in the system controller into analog signal of
intermediate frequency;
a forth SAW filter for bypassing response signal of intermediate frequency
received from the first D/A converter;
a forth frequency converter for converting the response signal of intermediate
frequency passed though the forth SAW filter into response signal of RF band;
a forth band limited-filter for band-passing a desired band signal among the
signal received from the forth frequency converter;
a forth-second amplifier for amplifying output signal of the forth band-limited
filter;
a first attenuator for adjusting the level of the amplified signal as control signal
of the system controller appropriately;
a first high-powered amplifier for amplifying output signal of the first attenuator
for sending the RF-band response signal to the reader through a circulator and a
transceiver antenna;
a second D/A converter for converting Shower channel signal passed through the
system controller into analog signal of intermediate frequency;
a fifth SAW filter for by-passing reader's query signal received form the second
D/A converter;
a fifth frequency converter for converting the reader's query signal of inter-
mediate frequency passed through the fifth SAW filter into a response signal
of RF band;
a band-limited filter for by-passing a desired band among the signal received
from the fifth frequency converter;
a fifth-second amplifier for amplifying output signal of the fifth band-limited
filter;
a second attenuator for adjusting the level of the amplified signal as control
signal of the system controller appropriately; and
a second high-powered amplifier for amplifying Shower channel output signal
passed through the second attenuator to send amplified signal to the tag through
the transceiver antenna.

The wireless communication device of an extensive RFID system for low-
powered reader-tag communication of claim 1, of which the communication
channel is separated with an arbitration communication channel $F_X$ used between
the reader and the wireless communication device; and a shower communication
channel $F_1 - F_N$ to amplify query signal of the reader for reader-tag com-
munication.

[3] The wireless communication device of an extensive RFID system for low-powered reader-tag communication of claim 1 or 2, wherein the system controller, to handle Arbitration query signal, comprising:

an Arbitration signal demodulator for detecting the level of input signal, deciding whether the detected level corresponds to 0 or 1 in comparison to threshold value, and so that demodulating base-band signal of query signal;

a CW interval detector for detecting a interval of which 1 continues over pre-determined length in demodulated signal, and decide the same interval as Start CW interval;

a CW interval level detector for detecting the level of CW interval input from detected CW interval; an output signal level calculator for calculating difference value to set level of response signal with a predetermined level for the detected input CW level;

a carrier frequency/phase manager for detecting and storing a reader's transmitting frequency to use the detected transmitting frequency as a carrier frequency and circulating repeatedly of stored frequency to maintain synchronized phase;

a CW level controller for controlling the level of stored CW transmitting frequency using calculated difference value; a query signal handling and response signal generating portion for clarifying reader's query signal of demodulated base-band by the Arbitration signal demodulator, checking whether the reader is in communication via Shower channel, and generating appropriate digital response signal of FMO or Miller including no response, Non-ACKnowledgement, and ACKnowledgement for the reader tried to communicate with a tag; and

a response signal modulator for modulating carrier frequency level adjusted to response of base-band generated by the query signal handling and response signal generating portion.

[4] The wireless communication device of an extensive RFID system for low-powered reader-tag communication of claim 1 or 2, wherein the system controller, to handle a query signal of shower channel, comprising:

a shower signal demodulating portion for detecting the level of input signal, and demodulating the query signal by comparing detected input level with a predetermined threshold value to decide 0 or 1;

a CW interval detecting portion for detecting an interval which 1 continues for a certain period or more among the demodulated signal, and deciding Start CW interval using the detected interval;
a CW interval level detecting portion for detecting level of CW interval input from the detected CW interval;
an output signal level calculator for calculating a difference value to control output level of shower channel output signal for adjusting output level to a pre-determined level for shower channel signal, and outputting an attenuator control signal;
a query signal manipulation and response signal generating portion for receiving reader query signal in digital format from the shower signal demodulating portion, and controlling the system controller to modulate the query signal as it is only for the query signal input after generating of ACK response in response to the arbitration query signal; and
a shower signal modulating portion for modulating shower channel signal in digital format as it is according to the control signal from the query signal manipulation and response signal generating portion.

The wireless communication device of an extensive RFID system for low-powered reader-tag communication of claim 4, wherein the carrier frequency/phase manager comprising:
a CW storing portion for storing Start CW interval of reader carrier; a circulating start point searching portion for searching a start point of interval among whole of stored CW interval to circulate repeatedly specific interval of Start CW for synchronizing in start point searching and settlement interval;
a circulation start point and end point searching portion for searching a reference value, searching to decide an end point by comparing reference value in an end point interval, and storing of the decided end point and completing of searching process;
a phase control portion for receiving memory address information of start point and end point from the circulation start point and end point searching portion and controlling of timing not to happen of phase difference in values in the memory address when it circulates; and
a CW circulating portion for circulating repeatedly values in memory addresses from the start address to the end address of which phase controlled, outputting transmitting CW for modulation of response signal as soon as it received a start time information of response signal the query signal handling and response signal generating portion , and completing output of carrier CW and circulating as soon as it receives a completing time information of response signal from the query signal handling and response signal generating portion.

A control method of the wireless communication device for sending/receiving arbitration query/response signal between the reader and the wireless com-
munication device to prevent readers from communication confliction in case that a plurality of readers exist simultaneously, the control method comprising:
a) filtering-out a desired frequency band from arbitration query signal input from a reader through a transceiver antenna;
b) demodulating the arbitration query signal to analyze and check the transmitted information from the reader, generating appropriate response signal according to active/non-active state of the shower channel if the information is not conflicted signal between readers, and modulating the generated response signal; and
c) filtering a desired frequency band from the modulated signal and outputting filtered signal.

The control method of the wireless communication device of claim 6, the b) step comprising:
detecting of CW interval among arbitration query signal input;
checking whether the detected CW interval is start CW interval or not, if so, detecting level of input signal in the start CW interval;
calculating of difference value to set level of response signal with a pre-determined level for the detected input CW level;
extracting of carrier frequency to be used for modulating base-band signal of arbitration response signal from the carrier frequency of the reader; and
doing the regulating of CW carrier level to maintain level of CW carrier equally considering the carrier frequency changes according to the level of reader signal.

The control method of the wireless communication device of claim 6, the extracting step of carrier frequency for modulating of response signal from the start CW carrier frequency of reader query signal comprising:
storing start CW of reader query signal;
searching circulation start point from CW values of digital format in the pre-specified start point searching/decision interval;
finding a reference value of circulation from CW values of digital format in the pre-specified end point searching/decision interval;
finding a circulation end point by comparing found reference value in the pre-specified end point decision interval, and completing storing of CW as soon as find out the circulation end point;
controlling phase not to be occurred any temporal phase difference of which values stored in memory address of start point and end point acquired by the above steps;
circulating repeatedly phase-controlled values stored in memory address of start point and end point acquired by the above steps to maintain same phase with the carrier frequency of the reader; and
outputting stored CW carrier which is circulating according to start/end time information of response signal.

[9] A control method of a wireless communication device with respect to a query signal of shower channel transmitted by a reader which is communication is admitted, after communication of arbitration between a plurality of readers and the wireless communication device, wherein the control method comprising:
a) filtering-out a desired frequency band from shower query signal input from a reader through a transceiver antenna;
b) demodulating of the shower query signal;
c) detecting CW interval among the arbitration query signal input;
d) checking whether detected CW interval is start CW interval or not and detecting level of input signal in the start CW interval;
e) calculating a difference value with refer to the detected level of input signal to adjust level to the pre-specified output level of response signal;
f) modulating modulated input signal as it is after detecting of CW interval; and
g) filtering a desired frequency band from the modulated signal and outputting the filtered signal.

[10] A wireless communication device of an intelligent RFID system for low-powered reader-tag communication, the wireless communication device for multi-readers-tags communication comprising:
a circulator for forwarding a reader signal of RF band received from a transceiver antenna to the first band-limited filter so that transmitting an arbitration
responding signal of RF band communication channel Fx received from a first
high-powered amplifier to the reader through the transceiver antenna;
a first low-noise amplifier for amplifying reader signal forwarded from the
circulator;
a first frequency converter for converting reader signal amplified by the first
low-noise amplifier to intermediate frequency;
a intermediate frequency divider for splitting and transmitting the reader signal
of intermediate frequency converted by the first frequency converter to an arbitration communication channel Fx and a shower communication channel F_1 - F_{N'}
a second SAW filter and a third SAW filter for band-passing the arbitration communication channel Fx or the shower communication channel F_1 - F_{N'} among the
input signal of intermediate frequency signals passed through the intermediate
frequency divider;
a first and a second A/D converter for converting intermediate frequency of
reader's arbitration signal or shower's query signal passed through the second
SAW filter and the third SAW filter to digital signal;
a system controller for clarifying digital reader signal input through the first and a second A/D converter, analyzing of arbitrating signal in case of arbitration query signal, checking whether the reader is at communication through the Shower channel or not and whether any conflicting is or not between readers by analyzing the arbitration signal in case of Arbitration query signal and generating appropriate response signal of FMO or Miller including no response, Non-ACKnowledgement, and ACKnowledgement for the reader tried to communicate with a tag, storing Start CW signal of reader for synchronizing frequency and phase of the Start CW signal with End CW signal during responding period, synchronizing frequency and phase of Start CW signal of reader and End CW signal using stored Start CW signal, modulating response signal using the synchronized signal as carrier frequency of response signal, forwarding shower channel signal after sending ACK response to Arbitration channel in case of Shower channel signal, and detecting input level of signals and generating control signal for output level;
a first D/A converter for converting the modulated Arbitration digital response signal of FMO or Miller generated in the system controller into analog signal of intermediate frequency;
a forth SAW filter for bypassing response signal of intermediate frequency received from the first D/A converter;
a forth frequency converter for converting the response signal of intermediate frequency passed though the forth SAW filter into response signal of RF band;
a forth band limited-filter for band-passing a desired band signal among the signal received from the forth frequency converter;
a forth-second amplifier for amplifying output signal of the forth band-limited filter;
a first attenuator for adjusting the level of the amplified signal as control signal of the system controller appropriately;
a first high-powered amplifier for amplifying output signal of the first attenuator for sending the RF-band response signal to the reader through a circulator and a transceiver antenna;
a second D/A converter for converting Shower channel signal passed through the system controller into analog signal of intermediate frequency;
a fifth SAW filter for by-passing reader's query signal received form the second D/A converter;
a fifth frequency converter for converting the reader's query signal of intermediate frequency passed through the fifth SAW filter into a response signal
of RF band;  
a band-limited filter for by-passing a desired band among the signal received from the fifth frequency converter;  
a fifth-second amplifier for amplifying output signal of the fifth band-limited filter;  
a second attenuator for adjusting the level of the amplified signal as control signal of the system controller appropriately; and  
a second high-powered amplifier for amplifying Shower channel output signal passed through the second attenuator to send amplified signal to the tag through the transceiver antenna;  
a third D/A converter for converting tag information response FMO or Miller generated by the system controller into intermediate frequency of analog signal;  
a sixth amplifier for amplifying intermediate frequency of response signal from the third D/A converter;  
a sixth SAW filter for band-passing response signal band of shower channel among the amplified signals; and  
a combiner for combining arbitration channel response signal of intermediate frequency and show channel response signal, so that transmitting stored in the wireless communication device to the reader with stored carrier frequency using carrier frequency of start CW.

A control method of the wireless communication device for sending/receiving arbitration query/response signal between the reader and the wireless communication device to prevent readers from communication confliction in case that a plurality of readers exist simultaneously, the control method comprising: a) filtering-out a desired frequency band from arbitration query signal input from a reader through a transceiver antenna;  
b) demodulating the arbitration query signal to analyze and check the transmitted information from the reader, generating appropriate response signal according to active/non-active state of the shower channel if the information is not conflicted signal between readers, and modulating the generated response signal;  
c) filtering a desired frequency band from the modulated signal and outputting filtered signal; and  
d) combining modulated response signal of arbitration channel and response signal of shower channel received from the tag and outputting the combined signal to the reader through the transceiver antenna.
[Fig. 6]

- Response signal (carrier CW)
- Start time and end time of response signal
- CW circulating portion
- Phase control portion
- Circulating start point searching portion
- CW storing portion
- Circulation start point and end point searched portion

Memory address of circulation start

305-2
305-1
305-3
305-4
305-5

Start CW interval signal
**A. CLASSIFICATION OF SUBJECT MATTER**

*H04B 5/02(2006.01)1*

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 H04B

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

Korean Utility models and applications for Utility models since 1975

Japanese Utility models and applications for Utility models since 1975

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

eKIPASS (KIP internal) "RFID, shower, multi tag, "

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>WO 2006-01 1208 A1 (MITSUBISHI ELECTRIC CORPORATION) 02 Feb 2007 Abstract, Fig 3, Claim 1</td>
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Further documents are listed in the continuation of Box C

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* Special categories of cited documents
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"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search

15 MAY 2008 (15 05 2008)

Date of mailing of the international search report

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Name and mailing address of the ISA/KR

Korean Intellectual Property Office
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LEE, Jin Ick
Telephone No 82-42-481-5770

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