Title: RADIO FREQUENCY IDENTIFICATION TRANSMITTING AND RECEIVING DEVICE

Abstract: A radio frequency identification (RFID) transceiver is disclosed, the transceiver characterized by: an antenna; a directivity coupler outputting a progressive wave signal inputted from the antenna and a reflection wave signal reflected from the antenna; a VSWR detector using the progressive wave signal and the reflection wave signal to detect a VSWR; a VSWR controller controlling a VSWR characteristic in response to the detected VSWR; and a phase/impedance controller using the controlled VSWR characteristic.
Description

Title of Invention: RADIO FREQUENCY IDENTIFICATION TRANSMITTING AND RECEIVING DEVICE

Technical Field

The present invention relates to a radio frequency identification transmitting and receiving device capable of transmitting and receiving an RFID signal.

Background Art

Currently, the ubiquitous technology is receiving increasing public sector and industry attention. The ubiquitous technology is a technology of a world of networked and interconnected devices that provide relevant content and information whatever the location or time of the user. An example of ubiquitous technology is a Radio Frequency Identification (RFID) technology, and an RFID technology that is introduced into business transaction is the most representative one.

Disclosure of Invention

Technical Problem

The present invention is disclosed to provide a radio frequency identification transmitting and receiving device (transceiver) capable of automatically adjusting a VSWR (Voltage Standing Wave Ratio) between an RFID reader and an antenna.

In some exemplary embodiments, the present invention provides a radio frequency identification transceiver capable of controlling an impedance of a connection terminal port between an antenna and an RFID reader to effectively manage an output loss of the reader, and automatically controlling a phase of a tag ID preamble error generating portion caused by phase change from reflection wave characteristic, thereby adjusting the recognition ratio degradation phenomenon.

The description herein explained is not intended to limit the scope of the present invention, and other undescribed problems may be clearly appreciated by skilled in the art from the following description.

Solution to Problem

According to a general aspect of the present invention, a radio frequency identification (RFID) transceiver is characterized by: an antenna; a directivity coupler outputting a progressive wave signal inputted from the antenna and a reflection wave signal reflected from the antenna; a VSWR detector using the progressive wave signal
and the reflection wave signal to detect a VSWR; a VSWR controller controlling a
VSWR characteristic in response to the detected VSWR; and a phase/impedance
controller using the controlled VSWR characteristic to adjust a phase and an
impedance.

[11] In some exemplary embodiments, the radio frequency identification (RFID)
transceiver may further include a standard signal detector detecting a VSWR standard
signal using a signal outputted from the directivity coupler, and the radio frequency
identification transceiver may further include a main signal processor outputting to the
VSWR controller the VSWR and the VSWR standard signal respectively inputted
from the VSWR detector and the standard signal detector.

[12] In some exemplary embodiments, the VSWR controller uses the detected VSWR and
the VSWR standard signal to control the VSWR characteristic, and wherein the phase/
impedance controller adjusts a phase and an impedance between the antenna and the
RFID reader.

[13] In some exemplary embodiments, the VSWR detector detects the VSWR based on
the following Equation 1, and wherein a transmission line impedance and an end
impedance are completely matched as the VSWR approaches 1 to prevent an incident
wave from being reflected and to allow all the incident wave to pass.

[14] Equation 1

[15] \[ V\text{SWR} = \frac{1 + |\rho|}{1 - |\rho|} \]

[16] where, \(\rho\) is a reflection coefficient.

[17] In some exemplary embodiments, the phase/impedance controller adjusts the phase
and impedance to adjust the reflection coefficient, whereby the VSWR can be automatically adjusted to cater to the environment.

[18] **Advantageous Effects of Invention**

[19] The present invention can automatically adjust a VSWR between an RFID reader and
an antenna according to environment by mounting a band control module to thereby
improve a reception sensitivity of an RFID transceiver and reduce the power con-
sumption by compensating an output.

[20]

[21] The present invention can automatically adjust a VSWR between an RFID reader and
an antenna according to environment to effectively manage a portion where output of
the RFID transceiver decreases, reception sensitivity decreases and tag recognition
ratio decreases and can automatically adjust the VSWR characteristic at a field to
improve the recognition ratio and to reduce the power consumption by compensating
the output.
[22] Brief Description of Drawings

[23] FIG. 1 is a control block diagram illustrating an RFID transceiver according to an exemplary embodiment of the present invention.

[24] FIG. 2 is a schematic view illustrating a VSWR detecting method of a VSWR detector of FIG. 1.

[25] FIGS. 3a to 3c illustrate a phase control method of a phase/impedance controller of FIG. 1.

[26] FIG. 4 is a functional block diagram illustrating an RFID transceiver according to another exemplary embodiment of the present invention.

[27] FIG. 5 is a schematic view illustrating a waveform of a signal detected by an RF detector of FIG. 2 according to an exemplary embodiment of the present invention.

[28] FIG. 6 is a schematic view illustrating a VSWR characteristic of an RFID transceiver according to an exemplary embodiment of the present invention.

[29] FIG. 7 is a schematic view illustrating a waveform of a signal transmitted from an RFID transceiver according to an exemplary embodiment of the present invention.

[30] FIG. 8 is a functional block diagram illustrating an RFID transceiver mounted with a frequency band module according to an exemplary embodiment.

[31] Best Mode for Carrying out the Invention

[32] Hereinafter, exemplary embodiments of the present invention are described in detail with reference to the accompanying drawings. Detailed descriptions of well-known functions, configurations or constructions are omitted for brevity and clarity so as not to obscure the description of the present invention with unnecessary detail. Furthermore, the same reference numerals will be assigned to the same elements in the explanation of the figures.

[33]

[34] FIG. 1 is a control block diagram illustrating an RFID transceiver according to an exemplary embodiment of the present invention.

[35]

[36] Referring to FIG. 1, the Radio Frequency Identification (RFID) transceiver according to the present invention may include an antenna (100), a phase/impedance controller (200), a directivity coupler (300), a VSWR detector (400), and a VSWR controller (500).

[37] The antenna (100) receives a reception signal inputted into an RFID reader and transmits a transmission signal outputted from the RFID reader.

[38] The directivity coupler (300) is interconnected between the antenna (100) and the
RFID reader to couple a progressive wave signal inputted to the antenna (100) for monitoring a radio frequency signal and a reflection wave signal reflected from the antenna (310) and outputs same.

[39] The VSWR detector (400) uses the progressive wave signal outputted to the directivity coupler (300) and the reflection wave signal to detect a VSWR.

[40] In telecommunications a standing wave ratio (SWR) is the ratio of the amplitude of a partial standing wave at an antinode (maximum) to the amplitude at an adjacent node (minimum), in an electrical transmission line. The SWR is usually defined as a voltage ratio called the VSWR, for voltage standing wave ratio.

[41] For instance, a progressive wave in two media having two different impedances is divided into a forward wave and a reflected wave by impedance mismatch, where a difference between the two waves is called the VSWR, for voltage standing wave ratio. If the reflection coefficient is defined as \( \rho \), the VSWR may be calculated by the following Equation 3.

\[
\text{VSWR} = \frac{1 + |\rho|}{1 - |\rho|}
\]

[42] That is, for example, the VSWR value 1.2:1 denotes a maximum standing wave amplitude that is 1.2 times greater than the minimum standing wave value. For another example, the VSWR value 1 denotes that a transmission line impedance and an end impedance are fully matched to allow all the incident waves to pass, and if the VSWR value is greater than 1, it means that incident wave is reflected more, such that the VSWR is an important index in checking whether an antenna is operating properly.

[43] As illustrated in FIG.2, the VSWR detector (400) may detect the VSWR between the antenna (100) and an RFID reader (700) by comparing a standard signal (A) according to an output control of the RFID reader (700) and an impedance change (B) according to an antenna (100) impedance and an external reflection wave.

[44] The VSWR controller (500) may control a VSWR characteristic based on the VSWR detected by the VSWR detector (400) and may be configured in an analogue circuit. The phase/impedance controller (200) uses the controlled VSWR characteristic to adjust a phase and impedance between the antenna (100) and the RFID reader.

[45] FIGS. 3a to 3c illustrate a phase control method of a phase/impedance controller of FIG. 1.

[46] As illustrated in FIG.3a, it can be noted that the phase and power level are changed by generation of reflection wave between the RFID reader (700) and the antenna (100). FIG.3b illustrates a phase waveform when the phase/impedance controller controls the phase at 40%, and FIG.3c illustrates a phase waveform when the phase/impedance controller controls the phase 90%.
FIG. 4 is a functional block diagram illustrating an RFID transceiver according to another exemplary embodiment of the present invention, where like operation of the RFID transceiver of FIG.4 as that of FIG.1 will be omitted in explanation.

Referring to FIG.4, the VSWR detector (400) may include an RF detector (410), an AD converter (420) and a signal processor (430).

The RF detector (410) detects an RF signal pulse outputted from the directivity coupler (330). In general, the RFID communication uses an ASK (Amplitude Shift Keying) modulation method, such that as shown in FIG.2, use of the RF detector (410) for recognizing a transmission command signal facilitates recognition of command from RFID reader (700) whereby conversion of transmission/reception mode can be eased.

FIG. 5 is a schematic view illustrating a waveform of a signal detected by an RF detector of FIG. 2 according to an exemplary embodiment of the present invention.

The signal processor (430) carries out an operation of Equation 1 to calculate a VSWR, where the calculated VSWR is inputted into a main signal processor (800). The RFID transceiver according to the present invention may further include a standard signal detector (600) detecting a VSWR standard signal using a signal outputted from the directivity coupler (300).

As shown in FIG. 4, the standard signal detector (600) may operate including a log detector (610), an amplifier (620) and an AD converter (630). The VWSR standard signal confirmed by the standard signal detector (600) is inputted to the main signal processor (800).

The main signal processor (800) outputs the VSWR and the VSWR standard signal respectively inputted from the VSWR detector (400) and the standard signal detector (600) to a VSWR controller (500), where the VSWR controller (500) controls the characteristic so that the detected VSWR is matched to the VSWR standard signal.

FIG. 6 is a schematic view illustrating a VSWR characteristic of an RFID transceiver according to an exemplary embodiment of the present invention.

As illustrated in FIG. 4, the VSWR controller (500) may include an AD detector (510), a signal processor (520) and an AD converter (530).

The phase/impedance controller (200) adjusts a phase and an impedance between the antenna (100) and the RFID reader (700) in response to the VSWR controlled by the VSWR controller (500). For example, the phase/impedance controller (200) can adjust the reflection coefficient () by adjusting the phase and impedance according to the controlled VSWR, whereby the VSWR is automatically adjusted according to environment.
FIG. 7 is a schematic view illustrating a waveform of a signal transmitted from an RFID transceiver according to an exemplary embodiment of the present invention.

As depicted in FIG. 7, the phase/impedance controller (200) may control the phase and impedance to adjust the reflection coefficient (r) in order to prevent a transmission signal higher than, for example, 30dBm (1W) from entering a receiving end, whereby the transmission signal can be reflected. Furthermore, query response and tag backscattering signal illustrated in FIG. 7 may be changed to reception mode and phase-corrected at a tag ID preamble section, whereby the phase correction is carried out through a phase converter of the reader at a section where an error is generated by a tag ID preamble signal inputted in a reverse phase due to the reflection wave signal.

FIG. 8 is a functional block diagram illustrating an RFID transceiver mounted with a frequency band module according to an exemplary embodiment of the present invention.

Referring to FIG. 8, the RFID transceiver may include a multi-band antenna (900) capable of transmitting and receiving various frequency band signals, for example, an approximately 900MHz to an approximately 2GHz which are UHF (Ultra High Frequency) bands.

Furthermore, unlike what is shown in FIG. 8, the RFID transceiver according to the present invention may be mounted with a plurality of antennae capable of transmitting and receiving signals of mutually different frequency band signals, that is, a first antenna capable of transmitting and receiving a 900MHz frequency band signal, and a second antenna capable of transmitting and receiving an approximately 2GHz frequency band signal.

As shown in FIG. 8, the RFID transceiver according to the present invention may include a plurality of band control modules (910, 920, 930) capable of automatically adjusting the VSWR in an RFID reader (940).

For example, a first band control module (910) may automatically adjust a VSWR of a first band signal out of various frequency band signals transmitted and received through a multi-band antenna (900), a second band control module (920) may automatically adjust a VSWR of a second band signal out of various frequency band signals transmitted and received through a multi-band antenna (900), and a n-th band control module (930) may automatically adjust a VSWR of an n-th band signal out of various frequency band signals transmitted and received through a multi-band antenna (900).

Configuration and operation of each of the plurality of band control modules (910,
920, 930) mounted on the RFID transceiver according to the present invention are the same as those of the RFID transceivers described with reference to FIGS.1 to 7.

That is, each of the first to n-th control modules (910, 920, 930) may include the phase/impedance controller (200), the directivity coupler (300), the VSWR detector (400) and the VSWR controller (500) as described in FIG.1, and may further include the standard signal detector (600) and the main signal processor (800) in addition to those constituent elements illustrated in FIG.4.

The number of plurality of band control modules mounted on the RFID transceiver according to the present invention is the same as the number of bands of signals transmitted and received by the multi-band antenna (900).

For example, in a case the multi-band antenna (900) transmits and receives 900MHz and 2GHz frequency band signals, the RFID transceiver may include a first band control module (910) automatically adjusting a VWSR of 900MHz frequency band, and a second band control module (910) automatically adjusting a VWSR of 2GHz frequency band.

Furthermore, in a case the RFID transceiver is mounted with a plurality of antennae transmitting and receiving band signals, each of the plurality of antennae may be connected to a band control module corresponding to a relevant band. For example, in a case the RFID transceiver is mounted with a first antenna transmitting and receiving 900MHz frequency band signal and a second antenna transmitting and receiving an approximately 2GHz frequency band signal, the first band control module (910) automatically adjusting the VSWR of 900MHz frequency band may be connected to the first antenna, and the second band control module (910) automatically adjusting the VSWR of 2GHz frequency band may be connected to the second antenna.

Industrial Applicability

The present invention has an industrial applicability in that, in view of the fact that a reflection wave is generated and an impedance mismatch is generated according to a reader, an antenna and an object to be recognized during RFID field installation, thereby generating a portion where a reader output decreases, a recognition ratio is degraded by tag phase change based on reflection characteristic, the RFID transceiver can effectively manage a reader output loss by controlling an impedance at a connection terminal port of the reader and the antenna, whereby the recognition ration degradation phenomenon can be adjusted by automatically controlling a phase of a portion where a tag ID preamble error is generated by the phase change based on the
reflection wave characteristic.

While the present disclosure has been particularly shown and described with reference to exemplary embodiments thereof, the general inventive concept is not limited to the above-described embodiments. It will be understood by those of ordinary skill in the art that various changes and variations in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.
Claims

[Claim 1] A radio frequency identification (RFID) transceiver, comprising: an antenna; a directivity coupler outputting a progressive wave signal inputted from the antenna and a reflection wave signal reflected from the antenna; a VSWR detector detecting a VSWR (Voltage Standing Wave Ratio) by using the progressive wave signal and the reflection wave signal; a VSWR controller controlling a VSWR characteristic in response to the detected VSWR; and a phase/impedance controller adjusting a phase and an impedance by using the controlled VSWR characteristic.

[Claim 2] The radio frequency identification (RFID) transceiver of claim 1 further comprising a standard signal detector detecting a VSWR standard signal using a signal outputted from the directivity coupler.

[Claim 3] The radio frequency identification (RFID) transceiver of claim 2 further comprising a main signal processor outputting to the VSWR controller the VSWR and the VSWR standard signal respectively inputted from the VSWR detector and the standard signal detector.

[Claim 4] The radio frequency identification (RFID) transceiver of claim 2, wherein the VSWR controller uses the detected VSWR and the VSWR standard signal to control the VSWR characteristic.

[Claim 5] The radio frequency identification (RFID) transceiver of claim 1, wherein the directivity coupler is connected between an antenna and an RFID reader.

[Claim 6] The radio frequency identification (RFID) transceiver of claim 5, wherein the phase/impedance controller adjusts a phase and an impedance between the antenna and the RFID reader.

[Claim 7] The radio frequency identification (RFID) transceiver of claim 1, wherein the VSWR detector detects the VSWR based on the following Equation 1, and wherein a transmission line impedance and an end impedance are completely matched as the VSWR approaches 1 to prevent an incident wave from being reflected and to allow all the incident wave to pass.

Equation 1

\[
\text{VSWR} = \frac{1 + |\rho|}{1 - |\rho|}
\]

where, \(\rho\) is a reflection coefficient.

[Claim 8] The radio frequency identification (RFID) transceiver of claim 7,
wherein the phase/impedance controller adjusts the phase and impedance to adjust the reflection coefficient, whereby the VSWR can be automatically adjusted to cater to the environment.

[Claim 9] The radio frequency identification (RFID) transceiver of claim 1, wherein the phase/impedance controller is connected between the antenna and the directivity coupler.

[Claim 10] The radio frequency identification (RFID) transceiver of claim 1, wherein the phase/impedance controller adjusts a reflection coefficient to allow reflecting a transmission signal having more than a pre-determined level.

[Claim 11] The radio frequency identification (RFID) transceiver of claim 1, wherein the VSWR controller comprises: an RF detector detecting a signal outputted from the directivity coupler; an AD converter converting an analogue signal detected by the RF detector; and a signal processor calculating a power level value of the converted digital signal.

[Claim 12] The radio frequency identification (RFID) transceiver of claim 1, wherein the antenna is a multi-band antenna, and the control module includes a plurality of control modules corresponding to a band control module corresponding to a relevant band.

[Claim 13] The radio frequency identification (RFID) transceiver of claim 12, wherein the multi-band antenna transmits and receives frequency signals of UHF (Ultra High Frequency) band which includes from 900MHz and 2GHz frequency band signals.