Title: WIRELESS COMMUNICATION SEMICONDUCTOR DEVICE HAVING A BIDIRECTIONAL WAKE-UP FUNCTION

Abstract: The present invention relates to a wireless communication semiconductor device. The wireless communication semiconductor device includes a data transmission/reception unit (100) for transmitting or receiving data to or from an outside, a wake-up signal transmission/reception unit (110) for receiving a wake-up signal to or from an outside, and a microprocessor (120). The microprocessor performs signal processing on data received from the data transmission/reception unit or transmitted signal-processed data to an outside through the data transmission/reception unit. The microprocessor wakes up in response to the wake-up signal received from the wake-up signal transmission/reception unit when in sleep mode. The wireless communication semiconductor device is in sleep mode, the data transmission/reception unit and the microprocessor are operating in sleep mode, and the wake-up signal transmission/reception unit is operating in an enabled state. The wireless communication semiconductor device of the present invention can minimize power consumption.
Description

WIRELESS COMMUNICATION SEMICONDUCTOR DEVICE HAVING A BIDIRECTIONAL WAKE-UP FUNCTION

Technical Field

[1] The present invention relates, in general, to a wireless communication semiconductor device, and, more particularly, to a wireless communication semiconductor device having a bidirectional wake-up function which can be used in a ubiquitous sensor network.

Background Art

[2] Generally, the term 'Ubiquitous Sensor Network: USN' means a network system in which a wireless sensor network is constructed using sensor nodes provided with sensors capable of sensing recognition information about objects or surrounding environmental information, and in which information, input through various sensor nodes, is connected in real time to external systems through the network and is then processed and managed. The ultimate purpose of a USN is to implement environments which enable communication anytime, anywhere, regardless of the networks, devices or services, by assigning computing and communication functions to all objects.

[3] A typical USN may include sensor nodes, each including a sensor for sensing recognition information about objects or surrounding environmental information in real time and a communication module, a sensor field composed of sets of sensor nodes, a sink node for receiving information collected by the sensor field, and a gateway for routing the information received from the sink node and transmitting the information to a management server over a wideband communication network. In the above construction, the sink node may be connected to the gateway through an existing infrastructure, such as satellite communication, a Wireless Local Area Network (WLAN), Bluetooth, or the wireless Internet. Such a USN may be used to sense the occurrence of disasters such as fires, floods, or earthquakes when they occur, and to cope with the disasters.

[4] Since the sensor nodes constituting the USN must be operated at low power, most of the sensor nodes are basically operated in a time-driven manner based on a periodic sleep mode and a wake-up function through the use of beacon signals or Time Division Multiple Access (TDMA). However, the time-driven manner is limited in that an immediate reaction is impossible during an unnecessary wake-up occurrence period and a sleep period.

[5] Meanwhile, in the prior art, in order to improve the low-power performance of sensor nodes, a software-based solution method using Media Access Control (MAC) or a
network algorithm has in most cases been searched for. However, such a conventional software-based solution method is limited because, in the case of the application of a mobile sensor node (a mobile terminal, a card terminal, a product tag, etc.) to which an external signal arrives at an arbitrary time, a reception unit must be continuously turned on, so that it is difficult to realize low-power and long-term use of sensor nodes.

Disclosure of Invention

Technical Problem

[6] Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide a wireless communication semiconductor device, which is operated in an event-driven manner based on a bidirectional wake-up function, thus being driven at ultra low power.

Technical Solution

[7] In order to accomplish the above object, the present invention provides a wireless communication semiconductor device, comprising a data transmission/reception unit provided with a transmission terminal (Tx_Data) and a reception terminal (Rx_Data), and configured to transmit or receive data to or from an outside through the transmission terminal and the reception terminal; a wake-up signal transmission/reception unit provided with a wake-up transmission terminal (Tx_Wake_Up) and a wake-up reception terminal (Rx_Wake_Up), and configured to transmit or receive a wake-up signal to or from an outside through the wake-up transmission terminal and the wake-up reception terminal; and a microprocessor configured to perform signal processing on data received from the data transmission/reception unit or transmit signal-processed data to an outside through the data transmission/reception unit, the microprocessor waking up in response to a wake-up signal received from the wake-up signal transmission/reception unit when in sleep mode, wherein when the data transmission/reception unit and the microprocessor are operating in sleep mode, the wake-up signal transmission/reception unit is operating in an enabled state.

[8] In the wireless communication semiconductor device, wherein when a signal, including a wake-up code, is received from the outside through the wake-up reception terminal (Rx_Wake_Up), the wake-up signal transmission/reception unit reads information about a wake-up target from the received signal, and generates an interrupt signal for the microprocessor and enables the microprocessor if the received signal is a wake-up signal for the wake-up signal transmission/reception unit itself, and then the microprocessor enables the data transmission/reception unit.

[9] Further, in the wireless communication semiconductor device, wherein when a signal, including a wake-up code, is received from the outside, the wake-up signal
transmission/reception unit reads information about a wake-up target from the received signal, and transmits the received signal to the outside through the wake-up transmission terminal (Tx_Wake_Up) if the received signal is a wake-up signal for another sensor node.

In addition, in the wireless communication semiconductor device, the data transmission/reception unit and the wake-up signal transmission/reception unit transmit or receive signals using different frequency bands.

Advantageous Effects

The wireless communication semiconductor device according to the present invention is configured such that, since, in sleep mode, only a wake-up signal transmission/reception unit driven at ultra low power is turned on and both a microprocessor and a data transmission/reception unit enter sleep mode, the semiconductor device can minimize power consumption when in sleep mode, in which data is neither transmitted nor received.

Further, the wireless communication semiconductor device according to the present invention enables a wake-up signal to be bidirectionally transmitted or received even when in sleep mode, thus transmitting a wake-up signal to another node of a network, as well as receiving a wake-up signal from another node, even when in sleep mode.

In addition, the wireless communication semiconductor device according to the present invention is configured such that both a data transmission/reception unit and a microprocessor are enabled only when a wake-up signal is received through a wake-up signal transmission/reception unit, thus reducing the entire power consumption.

Brief Description of the Drawings

FIG. 1 is a block diagram schematically showing the construction of a wireless communication semiconductor device according to an embodiment of the present invention; and

FIG. 2 is a flowchart sequentially showing the operation of the wake-up signal transmission/reception unit of the wireless communication semiconductor device according to an embodiment of the present invention.

Best Mode for Carrying Out the Invention

Hereinafter, a wireless communication semiconductor device according to embodiments of the present invention will be described in detail with reference to the attached drawings.

FIG. 1 is a block diagram schematically showing the construction of a wireless communication semiconductor device according to an embodiment of the present invention. Referring to FIG. 1, a semiconductor device 10 for wireless communication
includes a data transmission/reception unit 100 for transmitting or receiving data to or from the outside of the semiconductor device in a wireless manner, a wake-up signal transmission/reception unit 110 for transmitting or receiving a wake-up signal to or from the outside in a wireless manner, and a microprocessor 120. The wireless communication semiconductor device according to the present invention having the above construction is a new type of device for providing a wake-up function to a Radio Frequency (RF) microprocessor used in a Ubiquitous Sensor Network (USN) or Zigbee.

[19] The microprocessor 120 performs signal processing on data received from the data transmission/reception unit, or transmits signal-processed data to the outside through the data transmission/reception unit. When in sleep mode, the microprocessor 120 wakes up in response to a wake-up signal received from the wake-up signal transmission/reception unit. The wake-up signal is implemented using a frequency band differing from that of the data transmission/reception unit, and has therein a wake-up code and a destination address that are agreed upon. Therefore, the wake-up signal transmission/reception unit determines whether a received signal is an agreed-upon wake-up code and whether the destination of the received signal is the agreed-upon designation through comparison, and interrupts the microprocessor if the results of the determination match each other, thus enabling the microprocessor.

[20] The data transmission/reception unit 100 includes a transmission terminal Tx_Data and a reception terminal Rx_Data, and transmits or receives data to or from the outside. In an embodiment of the present invention, signals are transmitted or received in a frequency band of 2.4 GHz. Meanwhile, the data transmission/reception unit demodulates data received through the reception terminal and transmits the demodulated data to the microprocessor, or modulates data received from the microprocessor and transmits the modulated data to the outside through the transmission terminal. In particular, before transmitting data, the data transmission/reception unit performs a procedure for transmitting a wake-up signal to a destination address in advance, and enabling the data reception unit of a destination.

[21] The wake-up signal transmission/reception unit 110 includes a wake-up signal transmission terminal Tx_Wake_Up and a wake-up signal reception terminal Rx_Wake_Up, and transmits or receives a wake-up signal to or from the outside. When a wake-up signal is received from the outside, the wake-up signal transmission/reception unit wakes up the microprocessor by transmitting an interrupt signal to the microprocessor, or transmits the wake-up signal to another node through the wake-up signal transmission terminal. A detailed operation of the wake-up signal transmission/reception unit will be described later.

[22] When the wireless communication semiconductor device according to the present
invention enters sleep mode, the data transmission/reception unit and the micro-
processor are operating in sleep mode, and the wake-up signal transmission/reception
unit is operating in an enabled state.

[23] Hereinafter, with reference to FIG. 2, the operation of the wake-up signal
transmission/reception unit of the above-described wireless communication semi-
conductor device is described. FIG. 2 is a flowchart sequentially showing the operation
of the wake-up signal transmission/reception unit.

[24] When receiving a signal including a wake-up code from the outside at step 200, the
wake-up signal transmission/reception unit reads information about a wake-up target
from the received signal at step 210, and determines which node is the wake-up target
at step 220. When the received signal is a wake-up signal for the sensor node to which
the wake-up signal transmission/reception unit itself belongs, the wake-up signal
transmission/reception unit generates an interrupt signal for the microprocessor, thus
enabling the microprocessor at step 230. At this time, the microprocessor, having
received the interrupt signal, enables the data transmission/reception unit. The enabled
data transmission/reception unit receives data from the outside through its own
reception terminal Rx_Data and transmits the received data to the microprocessor.

[25] Meanwhile, in the reading procedure, when the received signal is a wake-up signal
for another sensor node, the wake-up signal transmission/reception unit transmits the
received signal to the outside through its own transmission terminal Tx_Wake_Up at
step 240.

[26] The data transmission/reception unit and the wake-up signal transmission/reception
unit of the wireless communication semiconductor device according to the present
invention preferably transmit or receive signals using different frequency bands, thus
enabling a data transmission path and a wake-up signal transmission path to be
separated from each other. At this time, the data transmission/reception unit, which
transmits or receives data, may use signals in a 2.4 GHz-band, and the wake-up signal
transmission/reception unit, which transmits or receives a wake-up signal, may use
signals in a 400 MHz-band.

[27] Meanwhile, the operation of a wireless communication network composed of nodes,
completed using the wireless communication semiconductor device according to the
present invention, is described below. In this case, the wireless communication
network is configured to transmit signals to respective nodes in a multi-hop manner.
Therefore, after relevant nodes are woken up by transmitting wake-up signals to the
nodes through the wake-up signal transmission path thereof, data is transmitted
through the data transmission path of each relevant node. Through this construction,
after the transmission/reception of data has been terminated, the microprocessors and
data transmission/reception units of the respective nodes constituting the wireless com-
munication network may be operated in sleep mode, and only wake-up signal
transmission/reception units, driven at low power, are enabled, thus minimizing power consumption of the nodes.

[28] **Industrial Applicability**

[29] A wireless communication semiconductor device according to the present invention enables the transmission or reception of bidirectional wake-up signals, and may be used as a sensor node constituting a wireless sensor network or a ubiquitous sensor network.
Claims

[1] A wireless communication semiconductor device, comprising:

- a data transmission/reception unit provided with a transmission terminal (Tx_Data) and a reception terminal (Rx_Data), and configured to transmit or receive data to or from an outside through the transmission terminal and the reception terminal;
- a wake-up signal transmission/reception unit provided with a wake-up transmission terminal (Tx_Wake_Up) and a wake-up reception terminal (Rx_Wake_Up), and configured to transmit or receive a wake-up signal to or from an outside through the wake-up transmission terminal and the wake-up reception terminal;
- a microprocessor configured to perform signal processing on data received from the data transmission/reception unit or transmit signal-processed data to an outside through the data transmission/reception unit, the microprocessor waking up in response to a wake-up signal received from the wake-up signal transmission/reception unit when in sleep mode, wherein when the data transmission/reception unit and the microprocessor are operating in sleep mode, the wake-up signal transmission/reception unit is operating in an enabled state.

[2] The wireless communication semiconductor device according to claim 1, wherein when a signal, including a wake-up code, is received from the outside through the wake-up reception terminal (Rx_Wake_Up), the wake-up signal transmission/reception unit reads information about a wake-up target from the received signal, and generates an interrupt signal for the microprocessor and enables the microprocessor if the received signal is a wake-up signal for the wake-up signal transmission/reception unit itself, and then the microprocessor enables the data transmission/reception unit.

[3] The wireless communication semiconductor device according to claim 1, wherein when a signal, including a wake-up code, is received from the outside, the wake-up signal transmission/reception unit reads information about a wake-up target from the received signal, and transmits the received signal to the outside through the wake-up transmission terminal (Tx_Wake_Up) if the received signal is a wake-up signal for another sensor node.

[4] The wireless communication semiconductor device according to claim 1, wherein the data transmission/reception unit and the wake-up signal transmission/reception unit transmit or receive signals using different frequency bands.
[Fig. 1]

DATA TRANSMISSION/RECEPTION UNIT

WAKE-UP SIGNAL TRANSMISSION/RECEPTION UNIT

MICROPROCESSOR

[Fig. 2]

START

S200

WAKE-UP SIGNAL RECEIVED?

READ TARGET INFORMATION FROM WAKE-UP SIGNAL

S210

WAKE-UP SIGNAL FOR SENSOR NODE TO WHICH WAKE-UP SIGNAL TRANSMISSION/RECEPTION UNIT ITSELF BELONGS?

S220

S230

YES

TRANSMIT WAKE-UP SIGNAL TO SUBSEQUENT NODE

TRANSmit ENABLE SIGNAL TO MICROPROCESSOR

NO

TRANSmit ENABLE SIGNAL TO MICROPROCESSOR

NO

TRANSMIT ENABLE SIGNAL TO MICROPROCESSOR

NO
A. CLASSIFICATION OF SUBJECT MATTER

H04B 7/26(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 H04B, H04L

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, DELPHION, ESPACENET & Keywords  USN, sensor, wake-up, power, save, time, event, enable, disable, interrupt and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>A</td>
<td>US2006-270381 A1 (PARK et al ) 30 November 2006 * abstract, figure 3 *</td>
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Further documents are listed in the continuation of Box C

See patent family annex

* Special categories of cited documents
  "A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search

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Date of mailing of the international search report

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Name and mailing address of the ISA/KR

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