ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

REVIEW ARTICLE

Use of 130 nm CMOS technology to enhance utility of Wake up receiver for Low Power applications: A review

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Manuscript Info

Manuscript History:

Received: 18 September 2014
Final Accepted: 29 October 2014
Published Online: November 2014

Key words

Wireless sensor networks, sensor nodes, Power consumption, Wake up receiver, CMOS technology.

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Abstract

Wireless Sensor Networks form an integral part of almost every domestic and industrial application. Considering the amount of Power required in energizing a sensor node, a more effective design of tuned RF receiver based Wake up receiver in 130nm CMOS technology of a 2.4 GHz ISM band consuming very low power of 69µA and operating at 1.2V has been proposed.

Introduction

Advancement in the field of Electronics and Communication has led to an immense necessity of sensors [1]. Sensors are compact, cost effective and consume low power. It is possible for sensors to communicate among themselves or as a network of devices with the help of a transceiver. Such networks are referred to as Wireless sensor networks (WSN). WSN are generally characterized by dense deployment of large number of small sized nodes and limited availability of power sources. WSN find large applications in Domestic, Industrial and Military areas.WSN still faces challenges such as limited power source that affects the lifetime of a sensor network, cost of installation, protocol for communication and size of the sensor nodes.

I. NODAL COMMUNICATION BETWEEN NODES

If waiting time is not the constraint, Data communication between nodes is quite energy efficient. Turning ON of the transceiver during data transfer and simultaneously its turning OFF after data transfer completion is referred to as Synchronous communication. Mechanisms other than the one discussed above are known as asynchronous communication [4].

A wake up radio is an additional radio which works as the device that wakes up the main transceiver to respond to the communication request which is sent by another wireless sensor node after which the transceiver again goes to sleep [6]. The wake up radio must always remain ON when transceiver goes to sleep and hence must be designed to consume extremely low power.

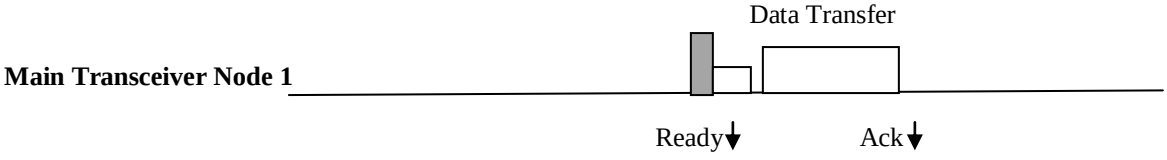

Figure1. Nodal Communication using a Wake up Receiver [4]

II. WAKE UP RECEIVER ARCHITECTURE CONSIDERATIONS

There are wide varieties of techniques to build a wireless receiver some of which may be complex systems having very high sensitivity of detection and some are simple Radio frequency identification (RFID) systems without simple power supply.

The high performance receivers are generally complex and thus consume unacceptable power whereas those receivers that consume less power have a very low sensitivity. It is required to propose a design of a receiver that consumes power in the range of 50 to 100 µW since the wake up receivers are expected to remain ON at all times. Some of the wake up receiver architectures proposed in recent publications [3] are given below.

A. Tuned RF receiver architecture.

The tuned receiver architecture given below is considered from the wake up receiver mentioned in. Fig below shows the tuned RF receiver block diagram.

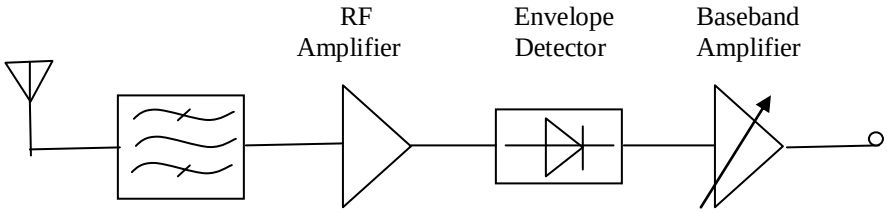

Figure2. Tuned RF receiver architecture

As shown in the figure above, the receiver consists of a Low noise amplifier, envelope detector and baseband amplifier. The LNA amplifies the weak high frequency RF signal; the envelope detector demodulates the RF signal which is further amplified by the baseband amplifier.

The tuned RF receivers are generally affected by flicker noise and are required to be demodulated to a higher frequency. Out of the total power consumed, almost 70% power is consumed by LNA only. A similar approach is followed in the work given in.

At 2.4GHz, the receiver offers a sensitivity of -53dBm and a total power consumption of 12.5µW respectively.

IV. CMOS TRANSISTOR OPERATING REGIONS

In general, a CMOS transistor operates in three operating regions viz. Linear, saturation and Cut-off [7] .A brief description of these operating regions is mentioned below [5].

- Linear region: This region has linear voltage to current characteristics.
- Saturation region: In this region, drain current follows a square-law relationship with gate voltage.
- Cut-off region: Drain current reaches almost to zero in this region.

Figure below shows an NMOS transistor along with its terminal voltages [7].

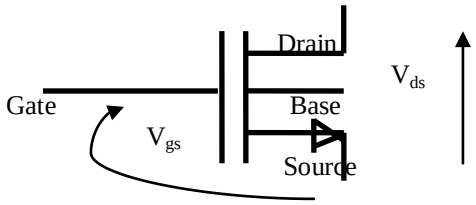

Figure3. NMOS transistor with its terminal voltages

The saturation region can be divided into additional three operating regions which are shown in the graph below [5].

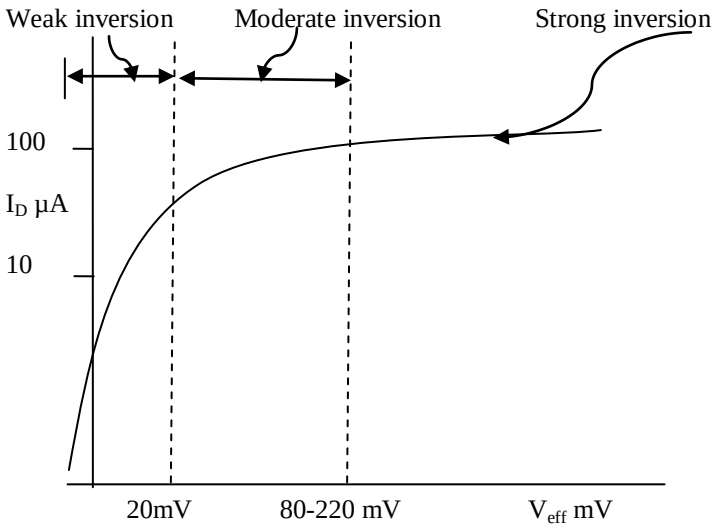

Figure4. Subdivided Active region of transistor

III. CONCLUSIONS

The wake up receiver discussed above using Tuned RF receiver architecture provides best ratings for Power and Sensitivity. Duty cycling can further enhance the power and sensitivity in addition to increased cost [2]. This wake up receiver can work on 69 µW of power at about 1.2V. Small changes in Low drop out voltage of about 1V and 1µA reference current is capable of reducing power consumption to about 50µW.

ACKNOWLEDGMENT

I would like to express my sincere gratitude to my guide Mrs. Monika S. Joshi whose help made this project successful. I would also like to thank Prof. Irshad Waheed who gave me conceptual understanding related to this work.

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