MSP 430 Controller based Wireless Communication using Transceiver CC2500 used in Bio-Medical Applications

T.Swetha[1], Santhosh Ayaluri [2]
[1]Asst.Professor, KMIT
[2]Project Associate, A.U

Abstract-*The main objective of the this paper is to establish ultra low power wireless communication between two RF modules consisting of MSP430F169 microcontroller and CC2500 RF transceiver and controlling the receiver by sending commands through the transmitter with very low power consumption. In idle mode both the IC's can enter sleep mode, which consumes in micro amperes current on 3.3V. This system simulates data with variable parameters of the receiver from the transmitter through RF communication. The system provides long battery life for the RF communication devices. This system can be used in ultra low power and battery powered applications especially in medical and consumer applications where frequent interactions between transmitter and receiver are required. In addition to low power the system is compact also.*

Keywords-ultra low power microcontroller MSP430F169, RF transceiver CC2500, RF Communication, wake on radio, low power modes.

I. INTRODUCTION

In present scenario embedded systems play major role in daily life and helpful in consumer, industrial and medical applications. There has been growing requirement in ultra low power consumption mechanism of the device and extended time of operation which is the most important criteria of consumer. Simultaneously Wireless networks prominence is increasing day by day for automation. Also the Power consumption is the most important feature of any wireless gadget, wireless network. In addition to long battery life low cost, minimum physical size is challenging for researchers. Ease of portability is also a considerable parameter.

Here, we developed embedded software and GUI software for the RF Transmitter and Receiver to establish a communication between two RF modules. The system consists of ultra low power Microcontroller and CC2500-2.5GHz RF transceiver with passive components. In this micro controller is interacted with transceiver by using SPI protocol and with PC by UART. PC is connected to Microcontroller through JTAG with MSP-FET430 debugger.

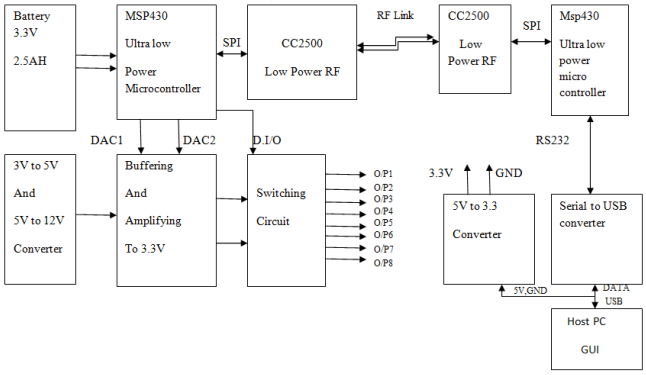

Fig 1.1: Interfacing of two RF modules

The above block diagram here explains two RF modules each consisting of Ultra low power MSP430F169 and RF transceiver CC2500 interfaced through a wireless RF link.

1.1 Steps Involved In Interfacing:

The software tools required are IAR Embedded Work Bench for MSP430 and Silicon labs CP210X USB to UART Bridge for Versatile Unit is installed in the PC (Personal Computer).

Procedure:

The hardware consists of ultra low power MSP430F169 microcontroller and ultra low power RF transceiver CC2500 with passive components. In this micro controller is interacted with transceiver by using SPI protocol and with PC by UART. PC is connected to Microcontroller through JTAG with MSP-FET430 debugger.

Wireless main control device is interfaced with pulse generator. Signal transmission between control unit & interfaced unit is through chip antenna, which has frequency range 2400-2500 MHz Programming language used in development of control unit is Embedded C program in IAR embedded Workbench.

For the user to operate in a comfortable manner the concerned GUI is also developed in visual basic. The GUI is developed in such a way that the user can easily control the various parameters and can also set up the maximum and minimum threshold levels of the parameters. Also the user can see the acknowledgement for the operation performed. The parameters can be used to control actuators, to stimulate organs.

1.2 Block diagram:

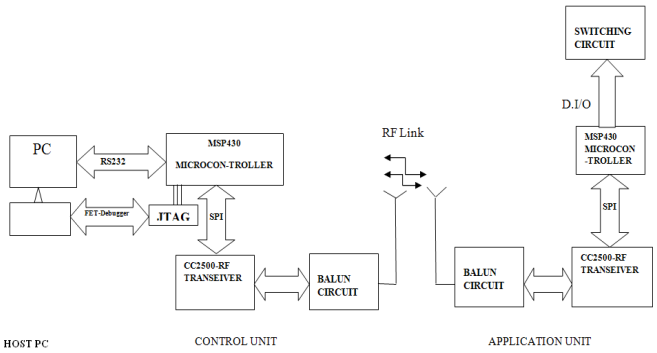

Fig 1.2: Application Block diagram

As shown in the Fig 1.2 the connections are given.
There are different blocks in the block diagram:

1. CC2500
2. MSP430F169
3. BALUN circuit
4. JTAG module

The CC2500 is a low power RF device, which transmit/ receive data from antenna through BALUN circuit. The CC2500 is controlled by a microcontroller MSP430F169 through SCLK, SI, SO & CSn (Chip select) pins of SPI. The microcontroller communicates to the PC through JTAG or RS232 module.

II. ULTRA LOW POWER MICRO CONTROLLER

MSP430F169

The microcontroller used for the application is MSP430F169.The Texas Instruments MSP430 family of ultra low power microcontrollers consists of several devices featuring different sets of peripherals targeted for various applications. The architecture, combined with five low power modes is optimized to achieve extended battery life in portable measurement applications. It has an ultra low power consumption of 330µA in active mode, 1.1µA in standby mode and 0.1µA in off mode (RAM Retention) .The device features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator (DCO) allows wake-up from low-power modes to standby mode in less than 6 µs. The MSP430F169 microcontroller configurations with two built-in 16-bit timers, a fast 12-bit A/D converter, dual 12-bit D/A converter, one or two universal serial synchronous/asynchronous communication interfaces (USART), I2C, DMA, and 48 I/O pins. Typical applications include sensor systems, industrial control applications, hand-held meters, etc.

III. CC2500 - 2.4 GHZ LOW POWER RF TRANSCEIVER

The CC2500 is a low-cost 2.4 GHz transceiver designed for very low-power wireless applications. The circuit is intended for the 2400-2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. It has a 400nA of sleep mode current consumption and fast start up time of 240usec from sleep mode. The RF transceiver is integrated with a highly configurable base band modem. The modem supports various modulation formats and has a configurable data rate from 1.2 to 500 kbaud.CC2500 provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication, and wake-on-radio. The main operating parameters and the 64-byte transmit/receive FIFOs of CC2500 can be controlled via an SPI interface. In a typical system, the CC2500 will be used together with a microcontroller and a few additional passive components.

IV. SOFTWARE IMPLEMENTATION

The programming code is dumped to the microcontroller by using IAR MSP embedded Workbench version 5.4.6. This software is to be installed in PC and we can write the code in it & dump into the microcontroller through MSPFET Debugger. The PC is connected to the Microcontroller through the MSPFET Debugger unit. The MSPFET debugger is connected to the MSP430F169 microcontroller through JTAG pins. The Graphical User Interface (GUI) is created for the front end application to modify the settings from the transmitter by using Visual Basic 6.0.

V. APPLICATION PROGRAM

The application program initializes UART1 in SPI mode in data simulation unit and establishes communication with CC2500.Through SPI; Micro controller initializes the

CC2500 by filling its configuration registers for required settings. Here dummy data from CC2500 is ignored.CC2500 is initialized in wake on radio and interrupt mode, where interrupt is generated on its GDO pins. After CC2500 initialisation, DACs and ADCs are initialised for data simulation and feedback measurement, battery voltage monitoring. Timer A is initialised in interrupt mode so as to generate interrupt for every 50µs.This time is used for controlling the parameters of simulated data.

The transmitting unit is programmed in the same as data simulation unit except for initialisation of ADCs and DACs, which are not required for control unit. UART1 is initialised in serial communication mode at 9600baud rate for communication with PC based GUI developed in Visual Basic. Each command starts with "$" and ends with "#" and command data is five Bytes for identifying different commands. The commands received from GUI will be transmitted by transmitter in low power mode. The received command generates interrupt, which wakes up the micro controller from low power mode. The command will be processed and decoded. Based on the command data simulation will be varied for various parameters. The total program is implemented in low power mode in addition low power consumption of MSP430F169 and CC2500.

VI. APPLICATION

For the pulse stimulation in medical application such as continuous stimulation at prescribed amplitude & pulse rate at disease affected organs. This circuit provides long battery life as it uses ultra low power microcontroller (MSP430F169) & low power RF communication chip (CC2500), which best suites medical applications.

Precise wireless control of digital motors in aerospace & defense application. Ultra low power communication between transmitting unit & controlling circuit like controlling large machines from distance where a person cannot reach the machine. Ultra low power wireless applications where battery life requirement is long such as remote controller for cars & other vehicles.

VII. FLOWCHARTS

7.1 Transmitter:

Transmitter receives commands from PC based GUI and after checking the validity of commands, they transmits via CC2500 and waits for receive acknowledge from receiver unit for confirmation of command reception.

The transmitter transmits until the acknowledgement is received. If the acknowledgement is not received until particular time it transmits the wrong acknowledgment namely acknowledgement time out.

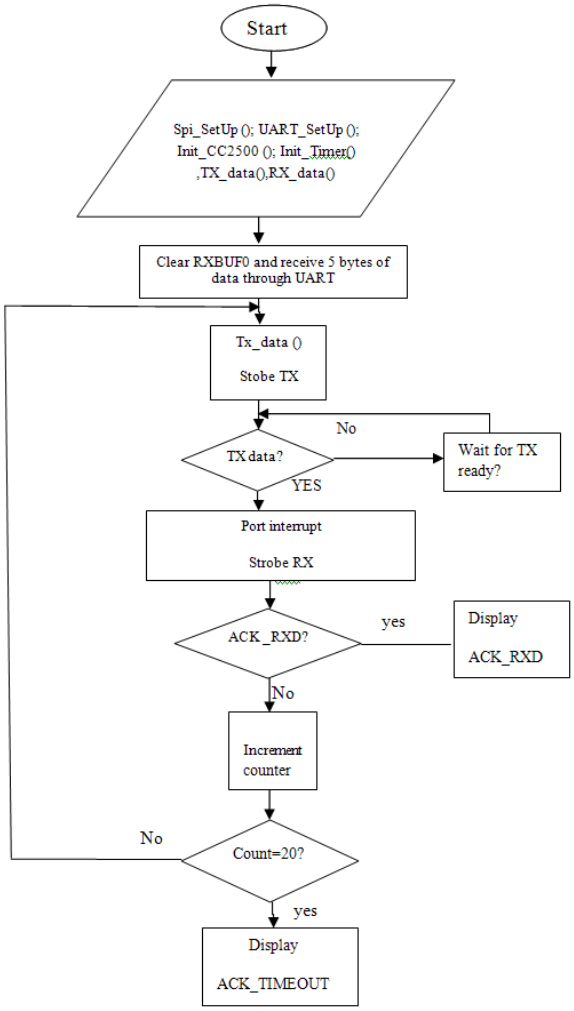

Fig 7.1 Flowchart of Transmitter

7.2 Receiver:

Receiver unit processes the commands received for their validity and then decodes the commands for identifying action to be performed i.e. varying different parameters of the receiver of simulated data. Receiver is programmed in interrupt mode for CC2500 data, which uses GDO pins for generating interrupts.

In detail, When the data is in between "$" and "#" the receiver receives the data and concerned action i.e. pulse amplitude, pulse rate, pulse width accordingly varied. And the acknowledgement for the safe data reception is transmitted back again to the transmitter. Otherwise the loop will again go back and waits for the proper command to receive. This action is performed until the correct data is transmitted.

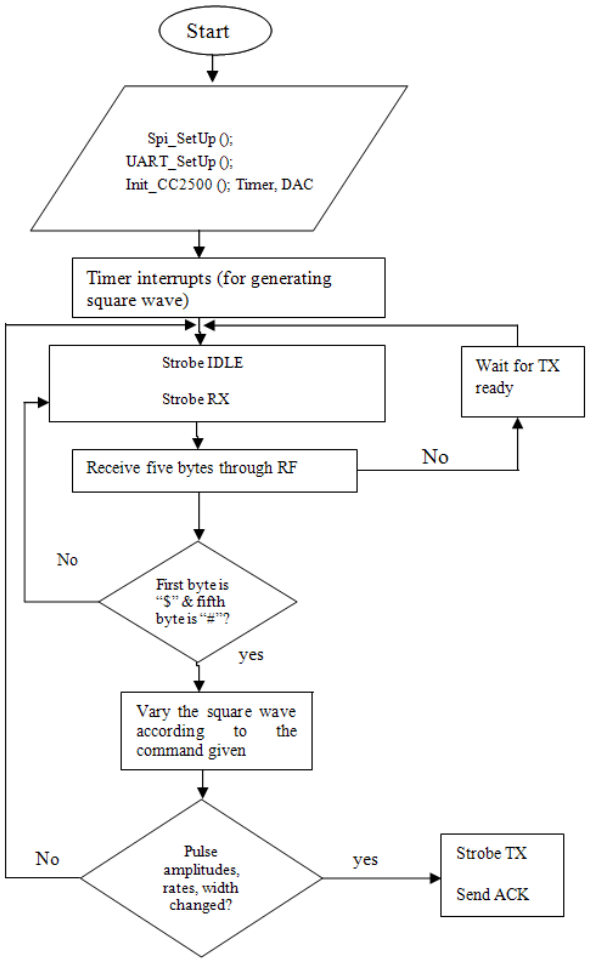

Fig 7.2 Flow chart of receiver

VIII. EXPERIMENTAL RESULTS

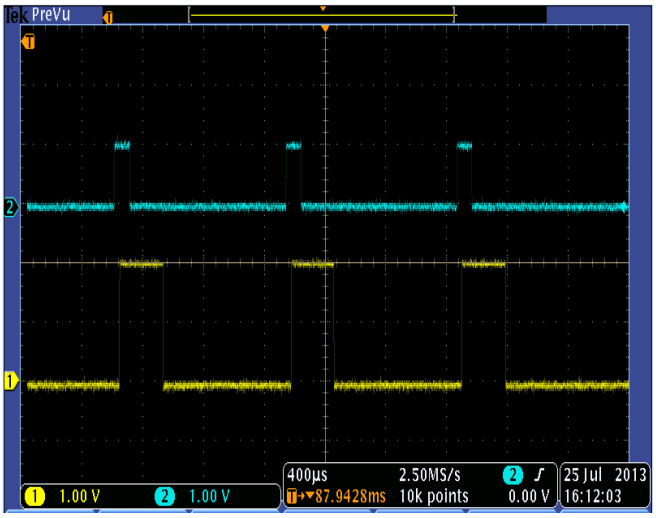

Fig 8.1 Output waveforms of the data

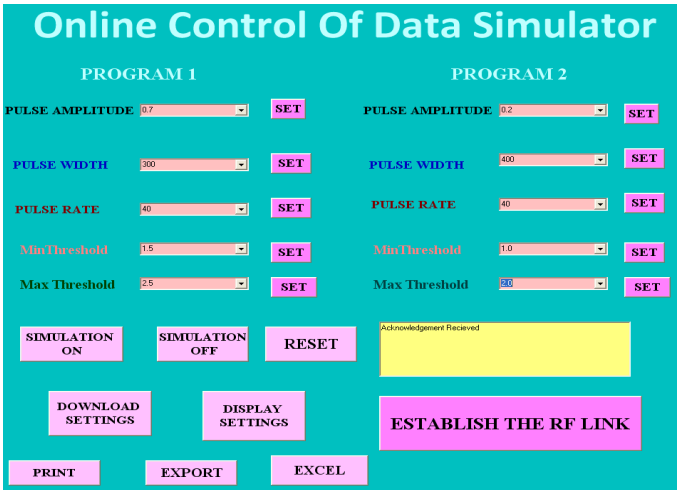

Fig 8.2 PC based GUI

XI. CONCLUSION

Here from this paper, we can conclude that wireless communication between the two modules consisting of MSP430F169 Ultra low power micro controller and CC2500 Low-Power RF transceiver consumes power in micro to milli watts based on application requirement. The communication protocol between pair of units is implemented effectively in command/respond mode with unique identification. Hence these modules can be used in applications such as medical implant devices and robotic applications, where battery life is crucial and compact solution is necessary.

REFERENCES

[1] Texas Instruments, "MSP430x13x, MSP430x16x, MSP430x14 Mixed Signal Microcontroller", August2008.

[2] Rahul Sarpeshkar,Michale S.Fee,Sam Musallam and Richard A.Andersen "Low-Power Circuits for Brain–Machine Interfaces" IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS, VOL. 2, NO.3, SEPTEMBER 2008.

[3] Texas Instruments, Diagnostic, Patient Monitoring and Therapy Applications Guide. 2010. [Online]. Available: http://focus.ti.com/lit/sg/slyb147a/slyb147a.pdf

[4] Texas Instruments, MSP430 Wireless Development Tool, eZ430-RF2500 Kit User's guide.Sep.2007.[Online].http://focus.ti.com/docs/toolsw/folders/print/ez430rf2500.html

[5] L.M.Li, H.W.Hao, B.Z.Ma ,X.W.Wen ,F.J.Liu and C.H.Hu "Development of Implantable Neuro-Stimulator Used for Brain and Nerve Stimulation"7th Asian-Pacific Conference on Medical and Biological Engineering IFMBE Proceedings Volume 19, 2008, pp 430-433.