Arduino based RF Compact Module for Short Range Wireless Communication using nRF24L01

Baishali De[1], Dr. Anirban Karmakar[2]
Department of Electronics and Communication Engineering,
Tripura University

Abstract- **With the advancement of communications technologies, wireless communication has become a popular tool in today's world, resulting in a variety of wireless communication protocols. Communication established between two modules in a short range opens a wide area of research work and can be implemented with IOT for many other applications. Having the characteristics of minimal power usage, cheap cost, peer to peer communication short range communication becomes more advantageous in comparison to others. Connecting wirelessly over vast distances gives up several of the options, including sensor systems monitoring and data, robot navigation, home automation and many more. When it comes to providing affordable yet effective full - duplex RF alternatives, no other components does a superior job than nRF24L01 transceiver module. Transceiver modules used in such cases comes on a very easy to handle as well as of low cost. RF transmitter and receiver, used in this project, plays a vital role when it comes to communicating over short ranges with a faster transmission data rate. nRF24L01 2.4GHz transceiver module is wireless radio frequency module in which each module has the ability to transmit as well as receive data. It works on nominal operating current 250mA with 250-2 Mbps transmission data rate within an operating range of 100meters.**

Keywords:- Wireless communication; transceiver module; microcontroller unit

I. INTRODUCTION

Wireless communication refers to the process of transmitting information between multiple sites without the need for physical connections like wires or cables. Radio transmissions are used in the most prevalent wireless technology to transmit information over long ranges. In order to transmit information without wires there is a necessitate for antenna. An antenna is a device that converts radio frequency energy from one medium (such as a waveguide or transmission line) to the other (i.e. air). There is requirement of two systems for data transmission viz. transmitter and receiver. In wireless communication, electromagnetic waves function as the medium for transmitting data over the channel between the transmitter and receiver.

As wireless frequency has the ability to penetrate the solid surfaces, wireless networks are simple to setup anywhere depending on requirements. This adaptability is a great asset of wireless communication making it widely usable in areas where wired-cable connection cannot be used. Wireless communication can be easily implemented by software configuration of frequency, power and other parameters which in turn saves time and human interface for wiring connection. The great benefit of such communication is that it can connect remote inaccessible areas due to its great mobility. Moreover, availability at cheaper rate results to implementation success of wireless communication due to competition in handset manufacturing segment.

Antennas are the gateways for wireless communication. Antennas convert the electronic signals into electromagnetic waves (radio waves) efficiently. In this project, nRF24L01, a wireless transceiver module is used as antenna in which each module can both serve as transmitter and receiver.

These module works in frequency of 2.4GHz within a range of 80-100 meters. Each module has a 125-bit address range and may connect with up to six other modules, allowing several wireless equipment to communicate with each other within its range. Since the module operates at 3.3V, it can be integrated with either 3.2V or 5V systems.

Many research works are carried out on wireless communication using various types of antennas. In this project, nRF24L01 transceiver module is used for communicating between two modules within required range. nRF24L01 is interfaced with Arduino Uno board which is a minimal-cost, versatile, and simple-to-use customizable open-source microcontroller board that may be used in a wide range of projects. The design of interfacing nRF24L01 with Arduino in this work complements the short communication between two points.

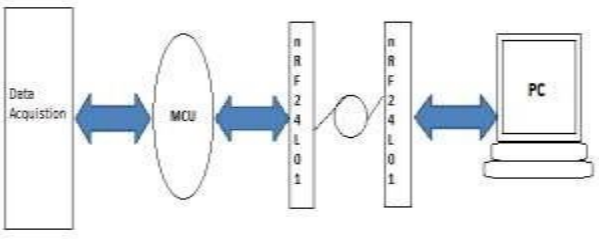

Fig.1: *Block diagram of wireless communication using nRF24L01*

The communication block diagram between the nodes based on the nRF24L01 or the PC described in the article is shown in the image above. The system functions on the following principle: 1) the nRF24L01 antenna gathers the data to be

sent to the other antenna and transmits the data through RF;
2) if the module is within the functioning range, the transmitted data is received by the receiver; 3) serial monitor of the receiver antenna displays the data which was sent from transmitter.

II. COMPACT-MODULE DESIGN

The design of RF compact module comprises of hardware schematic diagram and communication process between transmitter and receiver. It gives details about the nRF24L01-based sensors node. nRF24L01 transceiver module is a half-duplex multi-channel wireless communication microchip antenna which is fully integrated. It is characterized by its good sensitivity in transmitting and detecting received data along with better data transmit rate. It can support the data interface with microcontroller unit (MCU). In this paper, Arduino Uno is used as MCU. The Arduino Uno has an Atmega328 AVR microprocessor, six analogue input pins, and fourteen digital I/O pins, six of which are being used as output pin. The board is connected to the PC through a USB wire to embed or load the programs into the board. Arduino IDE (Integrated Development Environment). The package comprises a 32KB flash memory for storing the instruction set, as well as 2KB SRAM and 1KB EEPROM.

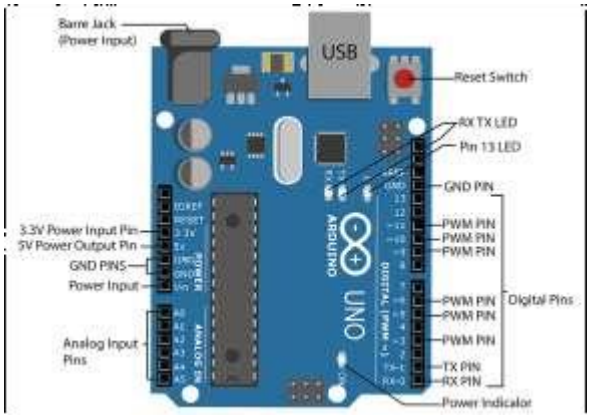

Fig.2: *Pin Diagram of Arduino Uno*

The nodes of the nRF24L01, on the other hand, are responsible for receiving data from existing network and transferring it to the gateway's MCU unit. At the same time, the node is responsible for relaying the gateway's instruction to the various other nodes within the network over short- range RF.

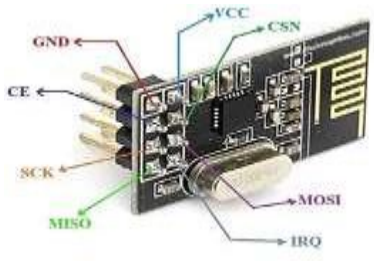

Fig.3: *Pin diagram of nRF24L01 transceiver*

The nRF24L01 is a single-chip radio transceiver that operates in the ISM band between 2.4 and 2.5 GHz. A highly integrated frequency synthesizer, a power amplifier, a crystal oscillator, a demodulator, modulator, and the Enhanced Shock Burst (TM) protocol engine are all included in the transceiver. A SPI interface allows for simple programming of output power, frequency channels, and protocol setup. At output, current consumption is of 9mA.

III. EXPERIMENTAL RESULT

RF based compact module using nRF24L01 supports bidirectional as well as multidirectional communication.

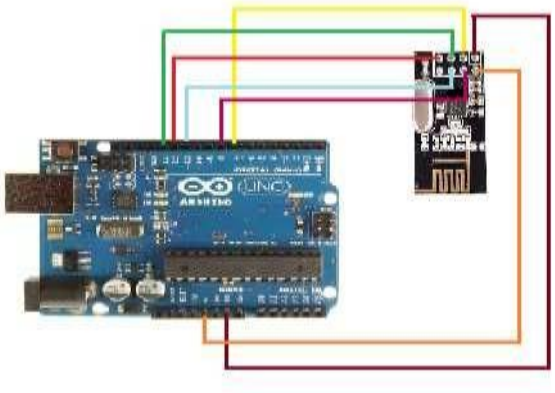

Fig.4: *Interfacing Arduino Uno with nRF24L01*

Above figure illustrates interfacing of nRF24L01 with Arduino Uno board. Transmitting and receiving modules have the same connection setup. Three of the nRF24L01 module's pins are being used for SPI communication and are connected to the Arduino's SPI pins. The pins CSN (Chip Select Not) and CE (Chip Enable) are used to configure the module in standby or active mode, as well as to switch between transmission and command mode, and can be attached to any digital pin on the Arduino board. CE pin is always an input with respect to transceiver module. It is used for controlling data transmission and reception when in transmitting and receiving modes, respectively. CSN enables pin for the SPI bus, and it is active low (hence the “not” in the name). The last pin is an interrupt pin that is generally not required in connection.

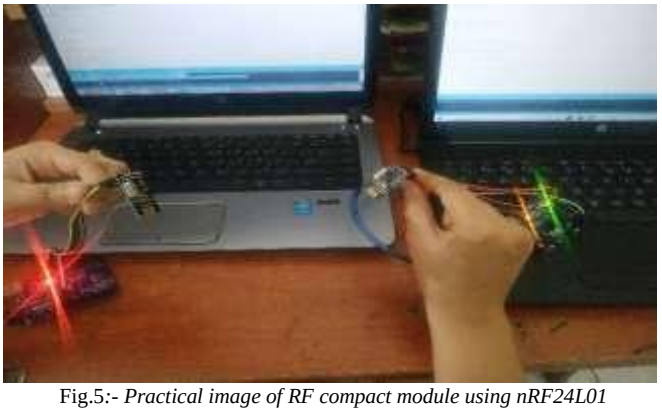

Fig.5:- *Practical image of RF compact module using nRF24L01*

Regardless of the fact that there are several variations of the nRF24L01 module, the on-board antenna is perhaps the most prevalent. The module becomes more compact as a result of this, however the transmission range is limited to around 100 metres. The data is transmitted from transmitter to receiver. The data received by receiver is printed on serial monitor of receiver on Arduino IDE software. In case of any transmitting issue such as interference and antenna failure a sending failure message gets printed on the serial monitor. This feedback-based communication system enables the user to easily detect the fault in transmission system.

IV. CONCLUSION

This paper presents the design of a simple RF compact module for short range communication. nRF24L01 2.4GHz transceiver module antenna transmits and receives data with a transmission speed up to 2Mbps. The principle of communication between two nRF24L01 is quite simple and easy. This module can also be merged with other system within desired range for monitoring sensor data, home automation and many more.

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