Universal Remote using PSOC with BLE

Akhilesh Chawla[1] Rahul Chudasama[2] Mitesh Gohil [3] Mandar Hanchate[4] Mahalaxmi Bhat[5]
[1,2,3,4]Student [5]Assistant Professor
[1,2,3,4,5]Department of Electronics and Telecommunication Engineering
[1,2,3,4,5]Atharva College of Engineering, Mumbai University,Mumbai, India

Abstract— Most of the household components like TV, AC and Music Player are Infra-Red (IR) based devices and thus have distinct remotes to operate them. Controlling different IR devices with their individual remote can prove to be cumbersome. Life would be much easier if there had been a single remote with a user friendly interface to operate all the IR devices. Due to the technological advancement and the need for smart home, we can tremendously reduce our dependence on remotes by making a multi-functional or universal remote that can operate all the IR devices. The paper put forwards an approach to completely remove the use of remote and utilize our android mobile with Bluetooth facility to control the home appliances. This paper stresses on the new technology evolved in the form of PSoC (Programmable System-on-Chip) with BLE (Bluetooth Low Energy) which is used to transmit the infra-red codes based on the protocols on which the devices work..

Key words: Infra-Red, remotes, PSoC with BLE, CySmart, IR protocols, modulation

I. INTRODUCTION

A universal remote depicts versatility in its usage by enabling the user to operate various electronic devices of different brands. Usually IR based remotes are used as they provide better signal to noise ratio, low power and secure transmission of information [2]. Initially remote controllers were used for radio frequency (RF) devices. The remote controllers used previously were kept for exclusive devices. This caused a great inconvenience for users who have multiple IR based electronic appliances as it became difficult to manage different remotes for different appliances. Therefore, it is essential to design a remote that not only served the purpose of multi-functionality but also provides low maintenance issues. Depending on the user requirements, these remotes are divided into various categories. Low-end remotes that operate using predefined set of IR codes used for specific devices. The high-end remotes are those which are flexible in terms of operating with IR codes [1]. To match these stressing demands, we have designed a universal remote which focuses on PSoC with BLE as the main centralized module. The PSoC with BLE is a latest version of the System-on-Chip module introduced by Cypress Semiconductors. The main advantage of using BLE is the low power consumption during its working and better operating conditions.

II. SYSTEM DESIGN

To begin with, selection of the various IR based devices which are to be operated using the universal remote and their respective brands was done. Out of the available choices, only those brands were selected which are extensively used like a Television of brands L.G, Sony, and Phillips and Air Conditioning System of L.G and Voltas. Based on the devices used, an intensive study was done on the IR protocols used by the respective device for transmitting an IR code for a particular operation. A remote sends different IR codes for different operation (Volume Up, Volume Down for a T.V or Temperature Up, Temperature Down for an A.C). These IR codes have different configurations as per the IR Protocol used for the devices. For a successful universal remote, one needs to be well versed with the IR Protocols used by the devices which are intended to be operated using the universal remote. Fig.1 shows the block diagram of the universal remote. The user transmits the code through an android application known as CySmart. The codes are sent through the CySmart application to the PSoC with BLE module through Bluetooth. Once the PSoC receives the codes, it then modulates the IR codes based on the frequency on which the IR protocols work. The modulated codes are sent to the respective appliance to be operated. The IR receiver in the appliance will decode the IR protocol used and will also extract the IR code present. The IR code obtained is then used to perform the required function.

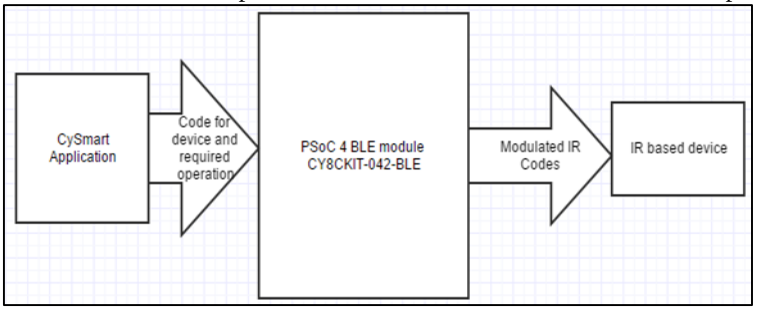

Fig. 1: Block Diagram

A. *IR (Infra-Red) Protocols*

All the IR based devices use IR signals for remote control. Different IR device manufacturers use different set of protocols to encode the data so as to eliminate interference between two devices. These protocols vary in terms of modulation frequency and number of bits (start, stop and data). An IR signal is a composition of pulses known as "marks" which are separated by intervals called as "spaces". An IR code is obtained by varying the timing interval of marks and spaces. These timing analysis data is further converted into a binary number up to 32 bits. The protocols used in this project are as follows:

1) NEC

This protocol is based on the pulse distance encoding of the bits. The size of the address and command is 8 bits. These bits are sent twice to ensure reliability. The carrier frequency used for this particular protocol is 38 kHz. In NEC protocol, the modulation is achieved through 560 us long 38kHz pulse. A logical "1" is denoted by 2.25 ms time interval whereas a logical "0 " is denoted by 1.12 ms.

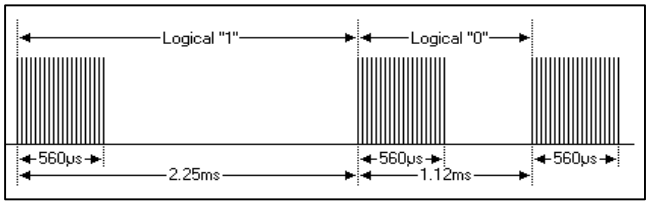

Fig. 2: NEC Modulation

The protocol that is used for encoding the data is initiated using a 9ms Automatic Gain Control (AGC) burst that is used for the setting the gain of the IR receivers [3]. This is followed by a 4.5 ms space, address and command. The modulation scheme and the protocol structure for the NEC protocol is shown in Fig.2 and Fig.3.

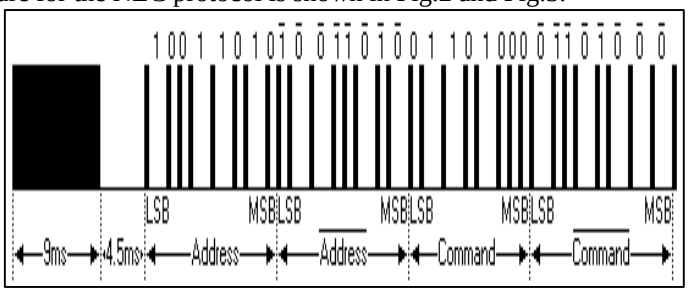

Fig. 3: NEC Protocol

2) *SONY SIRC*

The primary difference between SONY and NEC is the modulation technique used. The former uses the pulse width modulation whereas the latter uses the pulse distance modulation. The SONY protocol has 3 different versions known as 12 bit, 15 bit and 20 bit. All of these versions have 7 bit common for the command bits. This keeps 5 bit for address in the 12 bit version and 8 bit address for the 15 bit version. [4]. The 20 bit version has 5 bits for address and the remaining 8 bit are used as extended bits. The carrier frequency used for the modulation technique is 40 kHz. As shown in Fig.4, for a logical "1", a 1.2 ms long burst of the carrier frequency is used whereas for a logical "0", a burst of 0.6 ms is used.

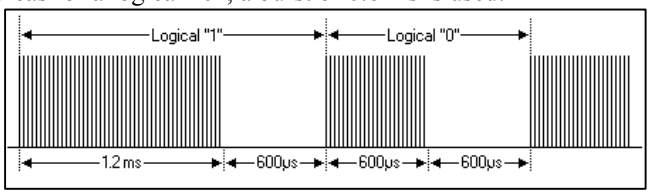

Fig. 4: SONY SIRC Modulation

As per Fig.5, a 12 bit version of SONY protocol is displayed where a start burst of 2.4 ms is first transmitted. Thereafter, the 7 bit command address and 5 bit address is transmitted. An interval of 0.6 ms is maintained throughout. As long as the key of the remote is held, the command is repeated after every 45 ms.

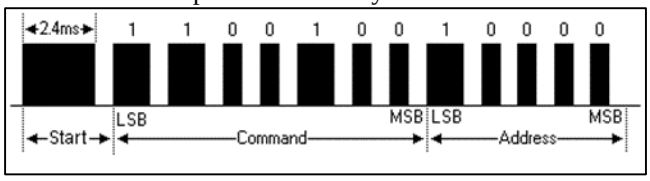

Fig. 5: SONY SIRC Protocol

B. PSOC with BLE

The programmable system on chip used for our project is PSOC 4 with BLE. The BLE module is used for transmission of IR codes from the CySmart application to the PSoC. The PSoC will then process the received codes as per the protocols declared within the code. A program code is constructed by the user where the required protocols and their respective modulation techniques are implemented. The PSoC with BLE acts like a centralized module that undertakes all the major processing

operation. The advantages of using the PSoC with BLE module is compact size and less consumption of power. This centralized module can be divided into 2 parts.

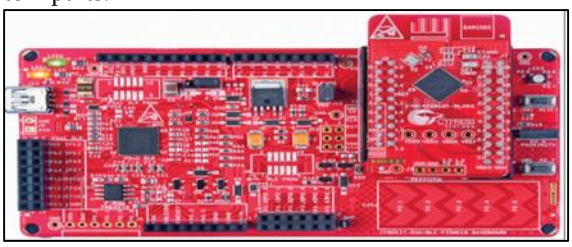

Fig. 6: PSOC 4 with BLE

1) *PSoC 4*

Fig.6 shows PSoC 4 with BLE module. The horizontal portion is the PSoC 4 device. The PSoC module comprises of ARM Cortex micro-controller M0 with an operating frequency of 48 Mhz. It is a mixture of microcontroller and programmable digital and analog blocks. The microcontroller used in PSoC 4 is ARM Cortex M0 which is a 32 bit subsystem. It also has 32kB of flash memory and 4 kB of SRAM [5]. It also consists of a capacitive touch sensor that can be used for various applications in the field of embedded systems. The PSoC 4 is a low power operating device with operating voltages varying from 1.7 V to 5.5 V. The PSoC 4 supports serial communication that can be used for various protocols like SPI, I2C or UART. The PSoC 4 can be programmed using PSoC creator that provides a user friendly environment for the users. The PSoC creator supports schematic design, physical mapping of pins and the code development.

2) *BLE (Bluetooth Low Energy)*

The BLE module is designed for applications that need to be operated on low power. BLE is aimed for low cost battery operated device that can quickly connect and form a secure wireless link for communication between 2 entities. Applications like sports and fitness monitor, remote controls and medical devices can be easily made using the BLE. In our project, we use BLE for reception of the code transmitted through the CySmart application for operating the device. The BLE is composed of BLE stack, Link Layer and the BLE Component hardware abstraction layer (HAL). The BLE stack is further divided into various layers like Generic Access Profile (GAPP), Generic Attribute Profile (GATT), Host control Interface, Link Layer and the Physical Layer [6]. The project of universal remote is made using a custom profile. The BLE module by Cypress has some inbuilt profiles like immediate alert service, blood pressure profile, find me profile etc that makes things easier for the user. In BLE, a communication link is established between central equipment and peripheral equipment. The type of equipment is defined by the GAP layer. The GAP layer is responsible for establishing and maintaining the connection. The peripheral device keeps sending the advertisement packets until intercepted by the central device. Once the central device scans the advertisement packet, pairing can be initiated between them. The GATT layer defines the functionality of the central and the peripheral device. These functionality are divided as service and characteristic.

3) *CySmart Android Application*

The CySmart android application is designed by cypress semiconductors specifically to send input data from the user to the PSoC with BLE Module. This android application is a Bluetooth low energy application which can be installed on all android mobile phones. CySmart application plays a crucial role in this project as the user transmits the code using this application. The CyBLE application will act as the actual remote where instead of pressing the button, we have to write the code for operating the required function of the required device. Fig.7 shows the usage of CySmart application. The CySmart application first detects the PSoC BLE module. Untill the PSoC BLE module is made discoverable, no connection will be established between the two and hence the centralized module or the PSoC BLE will not receive any data. The CySmart application after detecting the PSoC BLE will make a secure connection. Now the user starts sending the codes needed to operate the PSoC BLE. The codes will be sent as per the user requirement to operate a particular device. The CySmart has 2 sections of the code. The first section deals with the type of device and the second section is for the required operation. The user can modify the code and can also add reserved bits for future use or for security purpose.

Fig. 7: CySmart application

III. RESULTS

For the sake of getting a displayable output, a TSOP 1738 receiver that will demodulate and decode the code. The codes transmitted from the CySmart application is received by the PSoC through the BLE module. The PSoC after processing the required changes depending on the protocol makes the output available at the digital output pin. This pin (P 1(0)) is connected to an IR LED. This LED will blink for a particular code sent by the CySmart App. The IR LED transmits the signal just like a normal remote and the TSOP 1738 receives it. This TSOP receiver is connected to an Arduino board and using the concept of serial communication, the required output was displayed on the serial monitor screen. As shown in Fig.8, the output display allows the user the type of protocol used and the code for performing the required operation.

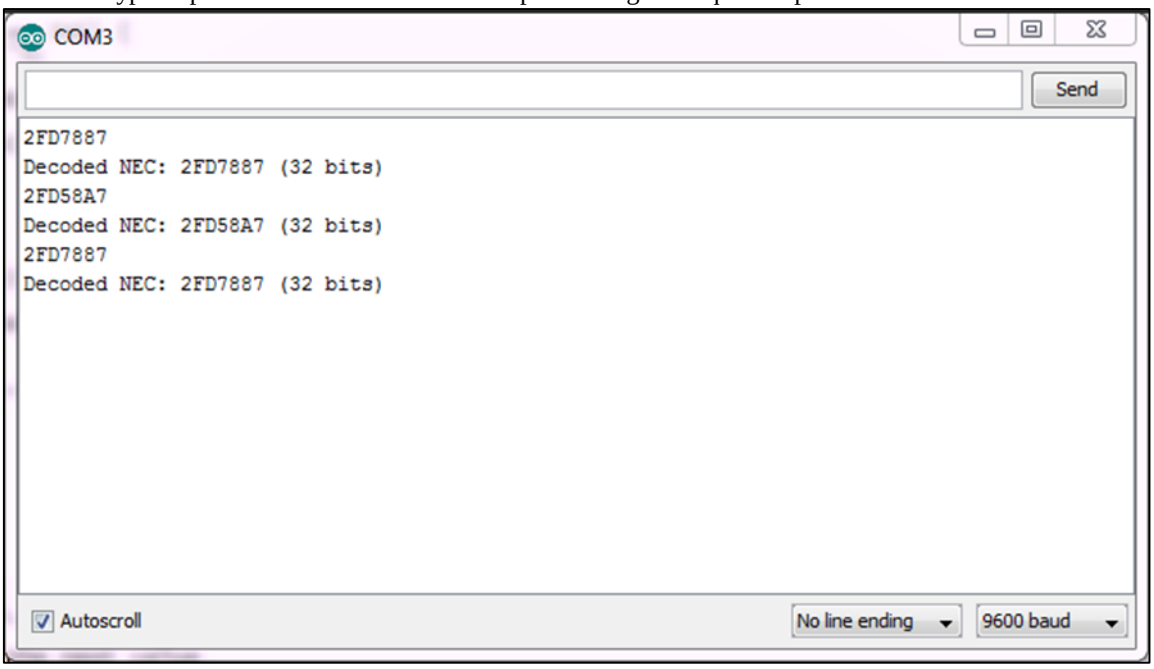

Fig. 8: Decoded Output for NEC (Volume Up and Down)

IV. CONCLUSION

Using the system design described above, a successful implementation of an universal remote was made that operates on 2 widely used protocols (SONY SIRC and NEC). The remote was able to operate the T.V and A.C of brand L.G which uses NEC protocol. It also operated a SONY T.V that works on SONY SIRC protocol.

ACKNOWLEDGEMENT

We would like to express our sincere thanks to Dr. Jonathan Joshi and Mr. Ganesh Gore, for giving us the opportunity to work on this project. They gave us the required encouragement and motivation throughout the project and it helped us to be focused and maintain our spirit. Their tips and suggestions helped us a lot to implement a novel project like this. We have been benefiting a lot from their immense knowledge and experience. We are also thankful to our college project guide Professor Mahalaxmi Bhat who helped us in receiving various facilities and services from the college. She provided a great deal of help, support and encouraged us to work diligently at every aspects of our project. Her supervision has allowed us to successfully implement this project.

REFERENCES

[1] Dr. Khanna SamratVivekanand Omprakash, "Concept of Remote controlling PC with Smartphone Inputs from remote place with internet", International Journal of Advanced Research in Computer Science and Software Engineering, Vol 2, Issue 1 January 2012.
[2] Gaurav Chitranshi, Madhvi Gaur," Using Android Mobile as a Universal Remote Control", International Journal of Engineering Research and Development, Volume 4, Issue 6 (October 2012), PP. 89-92.
[3] NEC Protocol http://www.sbprojects.com/knowledge/ir/nec.php
[4] SONY SIRC Protocol http://www.sbprojects.com/knowledge/ir/sirc.php
[5] PSoC 4 datasheet http://www.cypress.com/file/138656/download
[6] BLE datasheet http://www.cypress.com/file/137466/download