Wireless Home Alarm System Based on CC1110 and SimpliciTi

Zhijie Tang\textsuperscript{a}, Wang Shuaib, Luojun\textsuperscript{c}, a*

\textsuperscript{a}School of Mechatronics Engineering and Automation, Shanghai University, Shanghai, China
\textsuperscript{b}School of Mechatronics Engineering and Automation, Shanghai University, Shanghai, China
\textsuperscript{c}School of Mechatronics Engineering and Automation, Shanghai University, Shanghai, China

Abstract

This paper introduces the realization of the wireless home alarm focusing on the SimpliciTi protocol. Besides, this paper analyzes and summarizes the realization of wireless data transmitting and receiving of CC1110 and how to achieve DMA on CC1110, so it can be widely used, thus we can develop and research other wireless systems upon it.

1. Introduction

Networking will be one of the ways in which electronic products develop. We will use the wireless network in more electronic products because its easy installation, flexible extendibility, lower cost.

With a lot of influencing factors for example the defense areas in home alarm cover a lot of place, the defense areas in the room distribute dispersedly, home decoration shift and so on, it is easy to fix and maintain the systems when we select wireless communication.

Bluetooth, Zigbee, IEE802 are the most popular protocols in the field of short-distance wireless communication. After considering the code volume, power consumption and the cost, we select SimpliciTi protocol of TI Company. This communication protocol is free and runs on CC2510, CC1110 and MSP430 chips of TI Company. CC1110 is compatible with the 51 core, it is programmed in C language under IAR development environment, so the product is easier to achieve.

* Corresponding author. Tel.: +8621-56334137; fax: +8621-56334458
E-mail address: tangzhijie@shu.edu.cn.
2. SYSTEM ARCHITECTURE

Wireless home alarm system uses star topology, and the system is shown in Figure 1.

As shown, there are many devices in the home alarm system.

Defence areas controller: It is an end device of SimpliciTi, it receives the switching signals, digital signals or analogy signals from sensors, then transmit them to home alarm host computer through wireless method.

Range extension device: When the home alarm host computer can not receive the wireless signals or the signals are unstable because of beyond the distance problem, range extender can extend the transmitting distance, 4 level most.

Home alarm host computer: It is the data centre of the SimpliciTi, It manages all the terminal units in one house, query the online condition of terminal units, and process the alarm signals with alarm light or report to the community’s alarm system.

SimpliciTi supports three logical devices:

ED: End Device. It is used to collect the terminal data, the end device can be a battery-operated one.

AP: Access Point. It is used to implement management function in network; it would transmit the data from terminal unit to upper computer, or transmit them to data range extender.

RE: Range Extender, it is used to transmit the frames it received in order to expand the influence of end device or access point.

3. HARDWARE REALIZATION

The RF transceiver interface circuit is shown in Figure 2.
The circuit uses HMC226 to realize the switch of the receiving and transmitting of wireless system.
We choose one common emitter BJT to amplify in the transformation component, the amplification circuit uses BCR400W dynamic offset current control to eliminate the voltage fluctuation and temperature influence.

TS5A3160 is a single-pole double throw analog switching switch used to enable the power amplification component in the transmitter.

4. SOFTWARE REALIZATION

SimpliciTi based on Peer-to-Peer network, provides a convenient service about information communication. SimpliciTi can realize data encryption, frequency control, and network control and so on.

4.1. Layer stratifying

SimpliciTi protocol is not in strict accordance with OSI to divide layers. It may divide into parts shown below:

1) Customer applications
   Application is divided into two parts, user exploiting application and network management application. User exploiting application provides the API functions to users, these functions begin with "SMPL_ " such as SMPL_Init, SMPL_Link(), SMPL_LinkListen(), SMPL_Send(), SMPL_Receive, SMPL_IOCTL(). The codes of this layer are in the network group of protocol stack.
   Network management application extracts network application functions in abstract method; it provides basic network function to the application layer. The functions of this layer begin with "nwk_ " . There are Ping(), Link(), Join(), Security(), Freq(), Mgmt(). The codes are in the nwk application group of protocol stack.

2) Network

Fig.2 The circuit of wireless transferring
NWK configures the network when compiling or running, for example, basic frequency and frequency space, default key, device address and so on. The codes of this layer are realized in nwk application group of protocol stack such as SMPL_ioctl().

3) Minimal RF interface

MRFI realizes wireless corresponding functions in the bottom layer, the codes of this layer are in the MRFI group of protocol stack, the functions begin with “MRFI_” such as MRFI_Init(), the ground functions above this layer do not change with specific chip platforms and different development boards.

4) Boards Support package

BSP realizes the hardware drives of different development boards such as key and display and so on. It is in the BSP group of protocol stack, the functions begin with “BSP_” such as BSP_InitDrivers().

4.2. The structure of protocol stack of SimpliciTi

One stack of SimpliciTi has 22~74 bytes. The payloads of application program are \(0 \leq n \leq 52\). Payloads are loaded through SMPL_Send function of API.

We receive data via interrupt mode, the interrupt functions of CC1110 chip are in the file mrfi.c called by the mrfi group of hardware layer. The macro BSP_ISR_FUNCTION( MRFI_RfIsr, RF_VECTOR) declares the interrupt function.

5. IMPLEMENTATION

The CPU uses a set of command strobes to control operation of the radio in CC1110. You will realize the corresponding operation by assigning it: SFSTXON (0x00), SCAL (0x01), SRX (0x02), STX (0x03), SIDLE (0x04).

The radio is associated with two interrupt vectors on the CC1110. RFTXTXIE interrupt: RX data ready or TX data complete, corresponding with RFD register, its interrupt mask is TCON.RFTXRXIF, and interrupt enable bit is IEN0.RFTXRXIE. RF interrupt: There are eight kind of thing can generate the other interrupts: TX underflow, RX overflow, RX timeout, Packet received/transmitted, CS, PQT reached, CCA, SFD.

Initialize: It is to configure the wireless parameters by SmartRF Studio software and modify MRFI_Init() function of SimpliciTi.

Wireless transmission:
- Direct transmission: The data to transmit are written into Register RFD(0xd9), then the data can be transmitted after setting the RFST=STX (0x03).
- Transmission via DMA: Set a DMA channel, the source address is the data address to transmit to, destination address is RFD(0XD9), and the trigger mode is RADIO (19). You should configure the corresponding DMA before setting RFST=STX(0x03) to start transmitting the data.

SimpliciTi transmission: In fact, it is also the DMA transmitting mode. It is packaged in the SMPL_Send(lid,*msg,len) function. After establishing the connection, it is then to write the data to transmit into msg before calling the function to start transmitting the data.

Wireless receipt:
- Direct receipt: Set RFST=SRX(0x02) to start receiving(normally), wireless interrupt or the inquiry mode will inform the MCU that wireless data are coming, then directly receive the data from RFD(0XD9) register.
- Receipt via DMA: Set a DMA channel, the source address is RFD. The destination address is the address that will receive data from, the mode of triggering is RADIO(19). Configure the corresponding DMA, then set RFST=STX(0x03) to start receiving the data. When the wireless data are coming, DMA will write the data into the destination address automatically.
SimpliciTi receipt: The receiver function SMPL_Receive(lid,msg,len) does not affect the state of wireless, it only checks whether there is interrupt thread to fill the receive buffer, if filling, take out the data.

6. CONCLUSION

Wireless transfer has a widely application in the future. CC1110 is easy to use because of its 51 core. SimpliciTi matches CC1110 for its small code size. This paper applies it to the home alarm system, which gets perfect effect.

Acknowledgments

The authors would like to acknowledge National Natural Science Foundation of China (51005142, 50975168, and 60975068), National 863 Project (2009AA04Z211), and “Chen Guang” project supported by Shanghai Municipal Education Commission (10CG43) and Shanghai Education Commission Foundation (09zz091) for providing financial support for this work.

References

[1] Low-Power SoC(System-on-Chip) with MCU, Memory, Sub-1 GHz RF Transceiver, and USB controller CC1110FX DataSheet, TEXAS INSTRUMENTS