TEMPERATURE MONITORING SYSTEM

MOHD AZIZUL GHAFUR BIN RAHIMI

This thesis is submitted as partial fulfillment of the requirements for the award of the
Bachelor of Electrical Engineering (Control & Instrumentation)

Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

NOVEMBER, 2008

ACKNOWLEDGEMENT

Alhamdulillah, I am so thankful to Allah S.W.T for blessing me with good health, physical and mental and time, also giving me patient and spirit through this starting of my final year project. With mercifulness from Allah S.W.T, therefore I can start to create a useful and brilliance idea to this project.

To my beloved parent, Rahimi b. Mohamad and Rohani bt. Mansor, I am grateful to have both of you in my life and giving support through this life. Not forget, to all my friends, especially to my Bachelor of Electrical Control & Instrumentation (BEC), especially Mohd Shazni b. Saringat and Nasrung b. Nurba, who is part of my project that help me a lot in this making of this final project. May us all going through this final project together and success together.

I am also want to thank my supervisor, Mr Ayib Rosdi bin Zainun and Mr Reza Ezuan b. Samin, the lecturer from the Faculty of Electric and Electronic, for his advice, comment and generous support. Thank for your guidance and without your guidance this project cannot be started and will not well organized.

I also would like to thank all parties that involved in my final project, whether directly or indirectly in helping me to start this project and for their invaluable time, guidance and advice. That support although small, but it means a lot to me in order to make sure this project will be successful.

For the last, I will prepare my mind and body to face anything that coming in my way to finish this project. Thank you very much and may Allah S.W.T bless all of you.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Introduction

As time goes by, the improvement in technology growth larger, advance and more sophisticated. Long time ago, we never heard about temperature monitoring system or house monitoring system where the it can be detected by using wireless technologies application, GSM or using radio frequency technologies is great and back to previous era, people unable to imagine how the process work. But in this information era, it's become reality when a lot of industry and people used this technology to suit their need. At the other place, a group of expert people make a research to implement the use of radio frequency in monitoring the temperature to be more precise and reliable. It was another type of radio frequency technologies in the world.

As we know, radio frequencies refer to the frequencies that fall within the electromagnetic spectrum associated with radio wave propagation. When applied to an antenna, RF current creates electromagnetic fields that propagate the applied signal through space. Any RF field has a wavelength that is inversely proportional to the frequency and this means that the frequency of an RF signal is inversely proportional to the wavelength of the field.

It goes the same with this project that used the application of radio frequencies by using RF transmitter and RF receiver to monitor the temperature in the roof. The whole process that was described here is focus only on hardware part. It was known that when the temperature outside the house is rising, the area the sealed like in the roof will cumulate heat. So, in order to ensure that the temperature in that area do not rise so high that will make house resident feel not comfortable, sensor will detect the temperature and fan will do the job in stabilized the temperature. Thus, the system that can fulfill the requirement of this project is the circuit installed in the roof must consist of four main component which is temperature sensor to detect heat, PIC16F877A that can use to analyze the data and of course RF transmitter which is the function is to transmit the data to the receiver below to the user, the LCD use to display the value temperature and two LED indicator which is green for motor on and red for motor off. At the other side, the circuit in the house for user must have RF receiver to receive the data and PIC to analyzing the data which received and then communicate with LCD to display the data and also have two LED for motor indicator.

1.2 Problem statement

Temperature that so high especially in Malaysia always cause discomfort for house resident. The fan that available today for the roof is always on in order to keep roof compartment cool whether it hot or cool. It can cause electric waste and can burden the user. This project not only tell the value of temperature in the roof but also introduce smart fan that will active only at certain temperature and will turn off if the temperature drop below set temperature level. This will reduce the electricity cost for the consumer.

Due to the process of sending and receiving data there must be a transmitter and receiver to complete the task. Beside that, a PIC needs to be used to store and process the data then ordered LCD to display the data at the receiver.

1.3 Objectives

There are several objectives of this project which are:-

i. To make sure the temperature that been detected displayed correctly on LCD at transmitter board, fan will active at certain temperature and LED indicator behave correctly.
ii. To ensure the process of sending and receiving temperature value success using RF transmitter and RF receiver.

1.4 Project scope

i. Transmitter board will be installed inside the roof and receiver board will be placed in the house.
ii. Each time temperature changing, it will send the temperature value using RF transmitter to receiver in the house, fan and LED will work according to setting.

iii. Receiver board will receive the temperature value using RF receiver .Then LCD will display the temperature after get command from PIC16F877A and LED behave like it been program.

1.5 Thesis Outline

Temperature Monitoring System final thesis consist of 6 chapters that explain different part of the project. Each chapter elaborates all part of hardware and software about this chapter. The content also consist of information about the project and the component used as illustrate in literature review

Chapter 1 explains the introduction about this research where all the objectives and problems that lead to the implementation of this research are stated. The chapter starts with general information of radio frequency communication and the project background.

Chapter 2 explains the literature study regarding temperature monitoring system project based on recent journals and papers. The information also comes from few resources in internet that can be trusted. Generally, most of the literature discuss about project module from the basic concept to its application to this project and engineering fields.

Chapter 3 will be more focus on methodology and hardware used in temperature monitoring system project. Each module has its own connection and condition which need to put in consideration during the hardware constructing. This chapter also explains all the main circuit for each component in more detail.

Chapter 4 discuss about the software development hardware. All issues regarding the project such as the transmission and receiving data process will be discussed. Flow chart is used to show the whole process of transmitting and receiving data in this chapter.

Chapter 5 provides an outline of the results obtained from the transmitter board and receiver board. Detail explanation of the result starting from the input until the LCD display the output will be further discuss in this chapter.

Chapter 6 is the last chapter and it contains the brief summary for the whole research from the beginning until it is completed. Conclusion is included as well as some recommendations for future research on temperature monitoring system.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Inside this chapter, brief description on each project module that was used in this project will be stated. Besides that, some elaboration on fundamental of radio frequency and data transmission can be fined in this chapter.

2.2 How RF wireless connectivity work

RF is commonly used in the wireless communications industry to describe certain types of equipment which use radio frequency waves to transmit sounds and data from one point to another. In computer networking, RF is used to describe network devices such as hubs or bridge that transmits data signals using radio waves instead of data cables or telephone lines. Even though the phrase "RF wireless networking" might seem mysterious, the underlying technology is very common. It uses radio waves, the same type of energy used to transmit radio and television broadcasting. Two-way radios and walkie-talkies also use this kind of technology.

In the middle of the radio transmission and receiving process sit two antennas in two different places which is one located at the point for transmitting the signal and the other point is for receiving the signal. In order to transmit the modulated radio signal, an electrical current will pass through the antenna inducing a magnetic field, which oscillates at the given frequency. The variations in the current create slight variations in the radio frequency [1].

Thus, we should remember that the range we get depends on terrain, obstructions, and height of antenna. Buildings can reflect RF energy making it difficult or impossible to receive the desired signal. Also, if a reflected signal is bounced off of a building or other object, it can be received along with the direct signal. If the reflected signal is out of phase with the direct signal, it is possible for the direct signal to be partially cancelled by the weaker, reflected signal. Hence, the ideal conditions for best transmission and reception signal are line of sight and outside with no obstructions.

An RF wireless communication system operating in the presence of a periodic noise environment, includes first and second wireless devices, each such device having a source of power, a transceiver coupled to the power source, for transmitting and receiving wireless information, a controller or CPU for controlling the operation of the transceiver; means for detecting and mapping the presence of the RF radiated periodic noise and means responsive to the mapped periodic noise for controlling the operation of the transceiver to communicate with the other wireless device during the quiescent periods of the radiated RF periodic noise[2].

Then the CPU will control the operation of the transceiver in response to the mapped radiated RF periodic noise to communicate with the other wireless device during the quiescent periods of the radiated RF periodic noise by enabling the transmitter to transmit when it predicts the periodic noise is in the quiescent state, thereby making the transmission process efficient.

2.3 Data transmission

Data transmission is the conveyance of any kind of information from one space to another. Historically this could be done by courier, a chain of bonfires or semaphores, and later by Morse code over copper wires.

In recent computer terms, it means sending a stream of bits or bytes from one location to another using any number of technologies, such as copper wire, optical fiber, laser, radio, or infra-red light. Practical examples include moving data from one storage device to another and accessing a website, which involves data transfer from web servers to a user's browser. A related concept to data transmission is the data transmission protocol used to make the data transfer legible. Current protocols favor packet based communication. There were two types of data transmission which is serial transmission and parallel transmission.

Serial transmission bits are sent over a single wire individually. Whilst only one bit is sent at a time, high transfer rates are possible. This can be used over longer distances as a check digit or parity bit can be sent along it easily. But for parallel transmission, multiple wires are used and transmit bits simultaneously [3]. It works much faster than serial transmission as one byte can be sent rather than one bit. This method is used internally within the computer, for example the internal buses, and sometimes externally for such things as printers, however this method of transmission is only available over short distances as the signal will degrade and become unreadable, as there is more interference between many wires than between one.

2.4 RF fundamental

The wireless link consists of a transmitter with antenna, a transmission path and the receiver with antenna. Parameters of interest are the output power of the transmitter and the sensitivity of the receiver. Figure 2.1 illustrates the link principle.

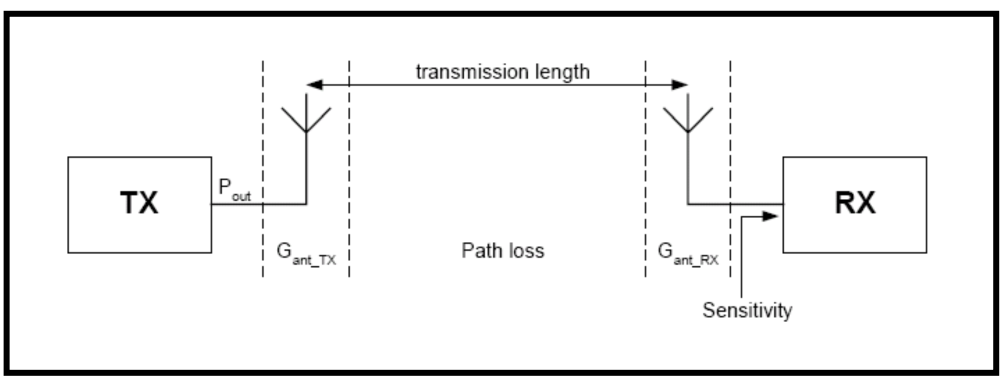

Figure 2.1 Wireless link

Sensitivity is the minimum received power that results in a satisfactory Bit Error Rate (BER, usually 1×10-3) at the received data output (i.e. correct demodulation). The difference between received signal power and sensitivity is the transmission link margin also known as ‘headroom’. Headroom is reduced by a number of factors such as transmission path length, antenna efficiency, carrier frequency and physical characteristics of obstructions in the transmission path. Sensitivity and output power given in the RF-circuit datasheets are given for the load impedance which is optimal for the input LNA and the output power amplifier. This means that the impedance of the antenna used must be equal to the load stated in the datasheet, otherwise mismatch and loss of headroom occur. A typical matching network introduces in the order of 1-3 dB of attenuation.

Radio Frequency (RF) waves are lower in frequency and longer in wavelength than Infrared. At 300 MHz the wavelength is 1 m (39.37") while Consumer IR wavelengths are just under 1 millionth of a meter. Most RF remotes use a carrier in the 300-1000 MHz range.

RF receiver only needs to be tuned to the carrier frequency used by the remote. RF remotes and their receivers are tuned to a fixed frequency. The FCC allows unlicensed, low power use of 300MHz-1000MHz as well as some higher frequency bands.

As a general rule, the codes are comprised of pulses and spaces with durations of 0.3-1.5 ms which is an audible signal in the 500-2000 Hz range as shown in Figure 2.2. The IR and RF receivers output the demodulated code waveform. The only difference is that IR receivers output an active low or inverted signal while RF receivers output an active high signal as shown on Figure 2.3.

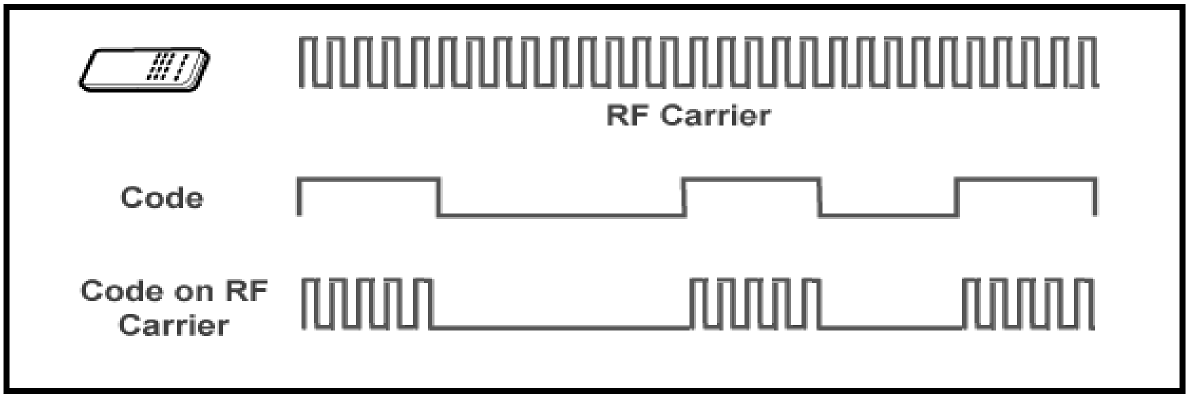

Figure 2.2 RF Carrier

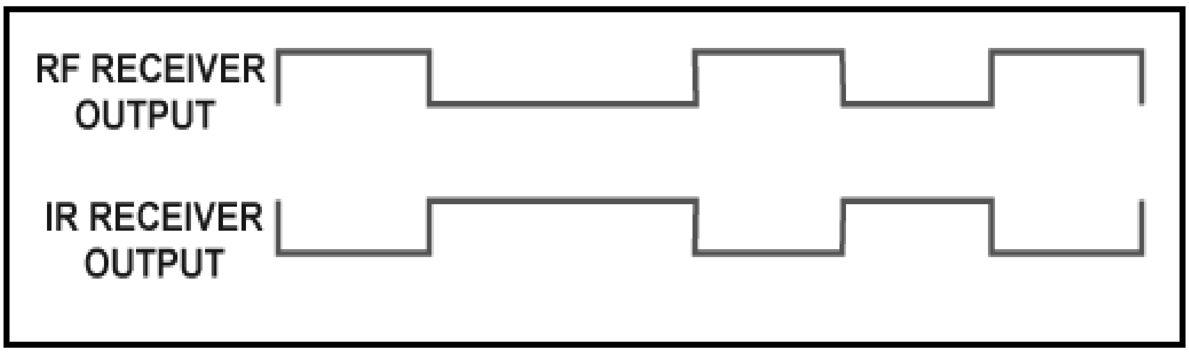

Figure 2.3 RF Receiver output & IF Receiver output

Other than range, it really makes no difference whether the data signal is used to modulate an RF carrier, an IR carrier, an ultrasonic carrier, a laser beam, or smoke. At the receiving end, the demodulated signal carries the same information. For RF control, both the transmitter and receiver need to be tuned to the same carrier frequency and need to use the same type of modulation.

Most RF remotes use ASK (Amplitude Shift Keying) or OOK (On-Off Keying). OOK is really just a special case of ASK. OOK is also called CPCA (Carrier Present, Carrier Absent). All of the illustrations above represent ASK. FSK (Frequency Shift Keying) uses two different carrier frequencies to denote two different states.

2.5 Voltage regulator

Voltage regulator ICs are available with fixed (typically 5 V, 12 V and 15 V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current (overload protection) and overheating (thermal protection).

Plenty of fixed voltage regulator ICs has three leads and looks like power transistors, such as the 7805 +5 V with 1 A regulator as shown in Figure 2.4. They include a hole for attaching a heat sink if necessary.

Voltage regulator will not stable if it work alone. Some capacitor in range 0.1 µF – 100 µF must be placed at pin 1 and pin 3. Voltage regulator will operate happily if there is a diode placed in pin 1 but it's not a compulsory. Diode can help to reduce the high voltage but it depends on the types of diode either it silicon, germanium or other models.

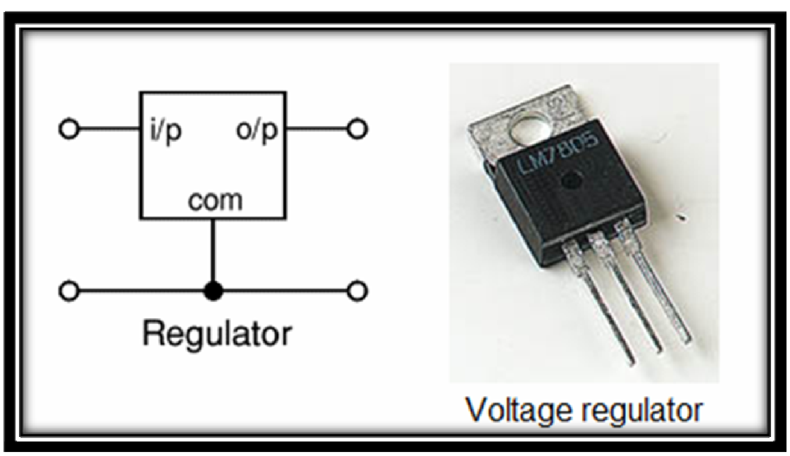

Figure 2.4 Voltage regulator

2.6 PIC16F877A

Many things should be considered before choosing a microcontroller as the controller. There is plenty of microcontrollers that was easy to find at electronics store such as ATMEL, Motorola's family and microchip product which is PIC. Basically this entire microcontroller capable to act as a controller but it's depends on the types of project that we build. It is because some of these microcontrollers have limited abilities in terms of lacking data memories and less of Input/output pins.

Amongst these microcontrollers, PIC6F877A have extra advancement. This device was build with special features such as 100,000 erase/write cycle enhanced flash program memory typical, self-reprogrammable under software control, In-Circuit Serial Programming via two pins, programmable code protection and power saving sleep mode. PIC16F87XA devices have a Watchdog Timer which can be shut-off only through configuration bits. It runs off its own RC oscillator for added reliability. There are two timers that offer necessary delays on power-up. One is the Oscillator Start-up Timer (OST), intended to keep the chip in Reset until the crystal oscillator is stable.

The other is the Power-up Timer (PWRT), which provides a fixed delay of 72 ms (nominal) on power-up only. It is designed to keep the part in reset while the power supply stabilizes. With these two timers on-chip, most applications need no external reset circuitry. The data EEPROM and Flash program memory is readable and writable during normal operation. This memory is not directly mapped in the register file space. Instead, it is indirectly addressed through the Special Function Registers. When interfacing to the data memory block, EEDATA holds eight bits of data for read/write and EEADR holds the address of the EEPROM location being accessed.

These devices have 128 or 256 bytes of data EEPROM with an address range from 00h to FFh. On devices with 128 bytes, addresses from 80h to FFh are unimplemented and will wraparound to the beginning of data EEPROM memory. When writing to unimplemented locations, the on-chip charge pump will be turned off.

When interfacing the program memory block, the EEDATA and EEDATH registers form a two-byte word that holds the 14-bit data for read/write and the EEADR and EEADRH registers form a two-byte word that holds the 13-bit address of the program memory location being accessed. For PIC16F876A/877A, addresses above the range of the respective device will wraparound to the beginning of program memory. The EEPROM data memory allows single-byte read and writes. The Flash program memory allows single-word reads and four-word block writes. Program memory write operations automatically perform an erase-before write on blocks of four words. A byte write in data EEPROM memory automatically erases the location and writes the new data (erase-before-write). The write time is controlled by an on-chip timer. The write/erase voltages are generated by an on-chip charge pump, rated to operate over the voltage range of the device for byte or word operations.

When the device is code-protected, the CPU may continue to read and write the data EEPROM memory. Depending on the settings of the write-protect bits, the device may or may not be able to write certain blocks of the program memory; however, reads of the program memory are allowed. When code-protected, the device programmer can no longer access data or program memory; this does NOT inhibit internal reads or writes. The picture of PIC16F877A can be see in Figure 2.5 and Figure 2.6.

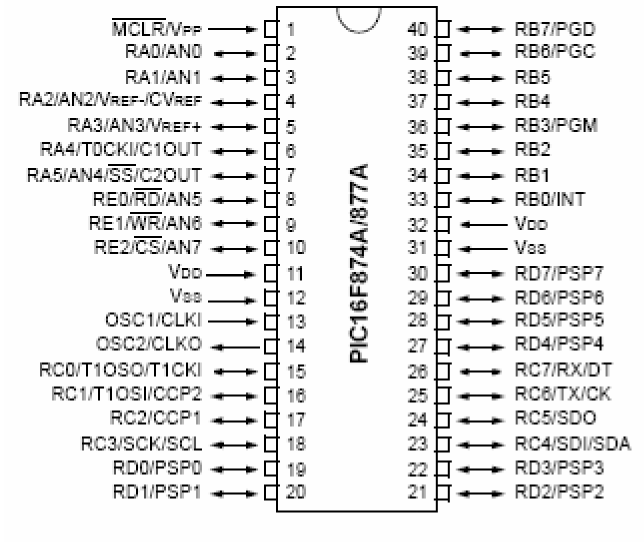

Figure 2.5 PIC16F877A

Figure 2.6 PIC16F877A

2.7 Transmitter module

A transmitter is an electronic device which with the aid of an antenna propagates an electromagnetic signal such as radio, television, or other telecommunications. A transmitter usually has a power supply, an oscillator, a modulator, and amplifiers for audio frequency (AF) and radio frequency (RF). The modulator is the device modulates the signal information onto the carrier frequency, which is then broadcast.

Sometimes a device like cell phone contains both a transmitter and a radio receiver, with the combined unit referred to as a transceiver. More generally and in communications and information processing, a "transmitter" is any object or source which able to sends information to an observer or receiver. When used in this more general sense, vocal cords may also be considered an example of a "transmitter"[4].

The transmitter module in Figure 2.7 was a RF transmitter which used in this project. The RF transmitter is placed at transmitter board inside the bus. The frequency range for this types of transmitter is 433 MHz and the modulation mode is ASK or amplitude shift keying mode. The temperature maximum rating is 230° C. The actual range for data transmitting is from 100 m to 150 m but it’s depends on the stability of power supply.

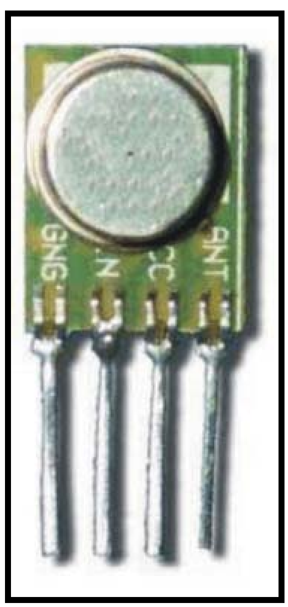

Figure 2.7 RF transmitter

Whenever possible avoid using bread-board or vary-board with RF transmitter. The long tracks inside these types of prototyping board introduce large capacitances or inductances to the circuit which can badly distort radio frequency signals. Ideally prototype or evaluation PCB should be used. Tracks connected to the antenna pin of transmitter modules should be as short as possible. Any conductor connected to this track will act as an antenna, so it will lengthen and detune the actual antenna. The suitable length of antenna for 433 MHz RF transmitter is 16 cm and above.

2.8 Receiver module

The receiver in information theory is the receiving end of a communication channel. It receives decoded messages or information from the sender, who first encoded them. Sometimes the receiver is modeled so as to include the decoder. Real world receivers like radio receivers or telephones can not be expected to receive as much information as predicted by the theorem. The receiver is designed to work with the matching transmitter. With the addition of simple antenna the pair may be used to transfer serial data up to 200 m. The range of the system depends upon several factors, principally the type of antenna employed and the operating environment. The 200 m quoted range is a reliable operating distance over open ground using 1/4 whip antenna at both ends of the link at 1.5 meters above ground.

Smaller antenna, interference or obstacles such as building will reduce the reliable working range (down to 30 meters in extreme cases). Increased antenna height, slow data or a larger receive antenna will increase the range. The RF module frequency is from 300 MHz to 434 MHz. Its high sensitivity passive design is simple to use with a low external parts count. An ASK data shaping comparator is included [5]. RF receiver in Figure 2.8 was the other types of superheterodyne receiver. This type of receiver supports the working frequency from 315 MHz to 433 MHz.

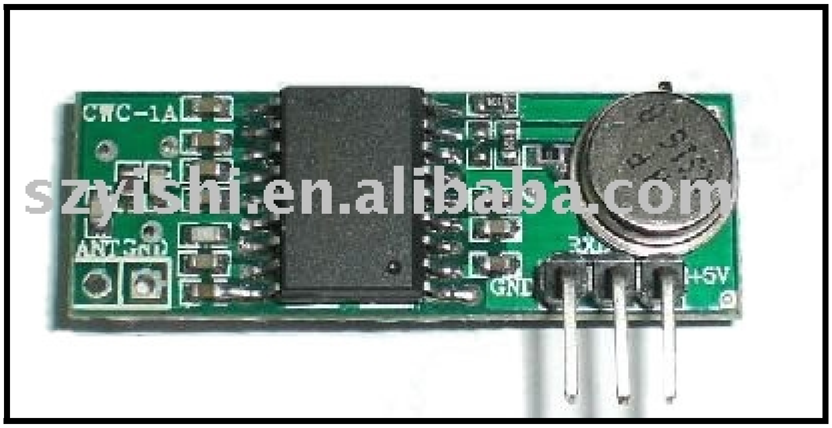

Figure 2.8 RF Receiver

The receiving sensitivity for this RF receiver is -101 dBm and the operating voltage supply is from 3 V to 6 V. Applying SAW crystal oscillation overcomes easy frequency excursion of LC circuit was the advantages of this RF receiver. Most parts of module are integrated into the chip 3310A, less external components, stable and reliable performance, and excellent anti-jamming ability.

The output data signal is TTL and can be directly connected to decoder. The antenna must be set to 16 cm length if the operating frequency is 433 MHz. These types of receiver are quite popular around few countries in Asia because it’s easy to get and the market is very wide compare to the European model of RF receiver.

The only problem of this type of receiver is the output of receiver module come with noise and also can create noise in case of special requirement, but the receiving sensitivity will be reduced. The output or RxD pin which receives a lot of noise will