DEVELOPING A REMOTE CONTROL FOR DIGITAL DATA TRANSMISSION USING INFRARED AND RADIO FREQUENCY

(WIRELESS COMMUNICATION)

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Abstract:

In this work we will first realize a TV remote control system. The system will allow digital data to be transmitted over a significant distance using a radio link where the input will be infrared (IR) signal. As a result the user will be able to control electronic devices from a distance. The system will be tested using an IR remote control to move a remote control car. The system will comprise of transmitting and receiving antennas, microcontroller, IR generator, IR sensor. This system will enable IR signal to be used on a device from a distance without any line of sight of the output device.

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Acknowledgement

We would like to acknowledge a few people who made this thesis work possible. Firstly we would like to express our deepest gratitude and sincere thanks to Ms. Farzana Shabnam, our thesis advisor, without her supervision, strong support and careful criticism we wouldn’t have been able to take this thesis so far. She enabled us to develop the core concepts and basics for understanding this topic.

We would also like to thank Allah, for helping us in this work, and giving us the ability to do the hard-work and determination that was required for this thesis.

INTRODUCTION

1.1 Motivation

Remote controls is a component of an electronics device most commonly used for controlling TV, DVD player and home theatre systems to operate on the devices wirelessly from short distance.

In this project we are trying to develop a multipurpose remote control. With which we will be able to control many things such as light, fan, tv, ac and so on. Our remote control device won't have any problem regarding wall penetration. It means it can penetrate concrete wall as it will send signal through radio frequency. The range of our remote control will be larger than the usual remote control.

The main technology used in home remote controls is infrared (IR). The signal between a remote control handset and the device it is controlling are infrared pulses, which are invisible to the human eye. The transmitter in the remote control handset sends out a pulse of infrared light when a button is pressed on the handset. A transmitter is often a Light Emitting Diode (LED) which is built into the pointing end of the remote control handset. The infrared light pulse represents a binary code that corresponds to a certain command, such as (power on). The receiver passes the code to a microprocessor, which decodes it and carries out the command.

To overcome the limitation of IR based remote control, we want develop a RF based remote control.

The first advantage of RF over IR is in the improved user experience and much better range. RF does not require the typical IR point-and-shoot action anymore. You can walk anywhere in the house and use the remote. You no longer have to be in the same room as your electronics in order to carefully take aim at the remote IR receiver. The RF remote control can transmit its signal through walls, doors and furniture, which makes it possible to install the set top box in a closed cabinet or a closet. With a stylish flat panel TV mounted on a wall, people prefer to hide the set top box in an equally stylish but closed cabinet, or even in another room. Since one set top box could service multiple screens in the house, one can imagine watching a movie in the living room, pausing to go upstairs and continue the view on the TV in the bedroom, controlling the set top box which is in the hallway, all via a single or multiple RF remote controls.

Another benefit of RF over IR is that RF allows two-way communication and enables a status display on the remote. With screens getting larger and viewers being further away from the TV, it becomes more useful to view the remote functionality (e.g. channel selection or audio volumes) on the remote control's display.

2 Equipments used in our designed of RF remote control

TX (Transmitter), RX (Receiver), Power Source (3V and 5V), Resistors, IR sensor, 2N3906, BS170, PIC16F84, Crystal Oscillator, IR LED,POT, Green LED.

RF Based Wireless Remote using RX-TX MODULES (434MHz.)

This circuit utilizes the RF module (Tx/Rx) for making a wireless remote, which could be used to drive an output from a distant place. RF module, as the name suggests, uses radio frequency to send signals. These signals are transmitted at a particular frequency and a baud rate. A receiver can receive these signals only if it is configured for that frequency.

The input at the transmitter side is IR signal. The IR signal will be

2.1 RF MODULES (434MHz)

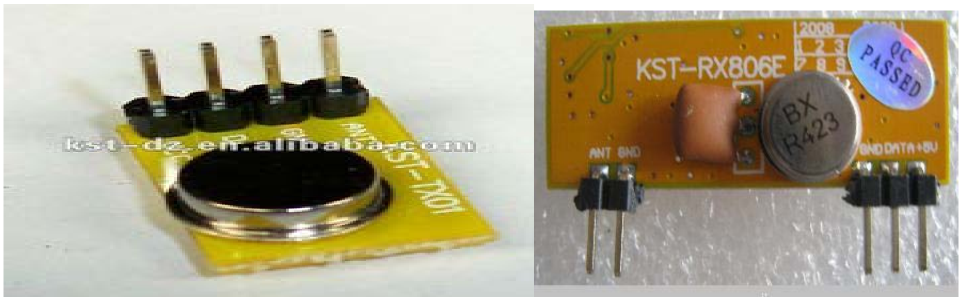


Figure: 01

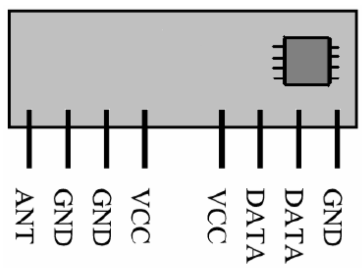
The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of- sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources.

This **RF module** comprises of an **RF Transmitter** and an **RF Receiver**. The transmitter/receiver (Tx/Rx) pair operates at a frequency of **434 MHz**. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

.**2.2 Pin Diagram**

Receiver Module | Transmitter Module



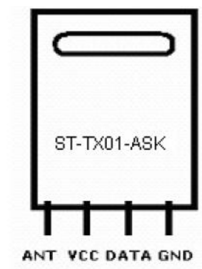


Figure: 02

2.3 Pin Description

Transmitter Module

Pin	Functi	Na
1	Ground	GN
2	Serial Data Input Pin	DAT
3	Supply Voltage (5V)	VCC
4	Antenna Output Pin	ANT

Receiver Module

Pin	Functi	Na
1	Ground	GN
2	Serial Data Output Pin	DATA
3	Linear Output Pin; Not	NC
4	Supply Voltage (5V)	VCC
5	Supply Voltage (5V)	VCC
6	Ground	GN
7	Ground	GN
8	Antenna	ANT

2.4 Micro controller

PIC16F84 has a total of 18 pins. It is most frequently found in a DIP18 type of case but can also be found in SMD case which is smaller from a DIP. DIP is an abbreviation for Dual In Package. SMD is an abbreviation for Surface Mount Devices suggesting that holes for pins to go through when mounting, aren't necessary in soldering this type of a component.

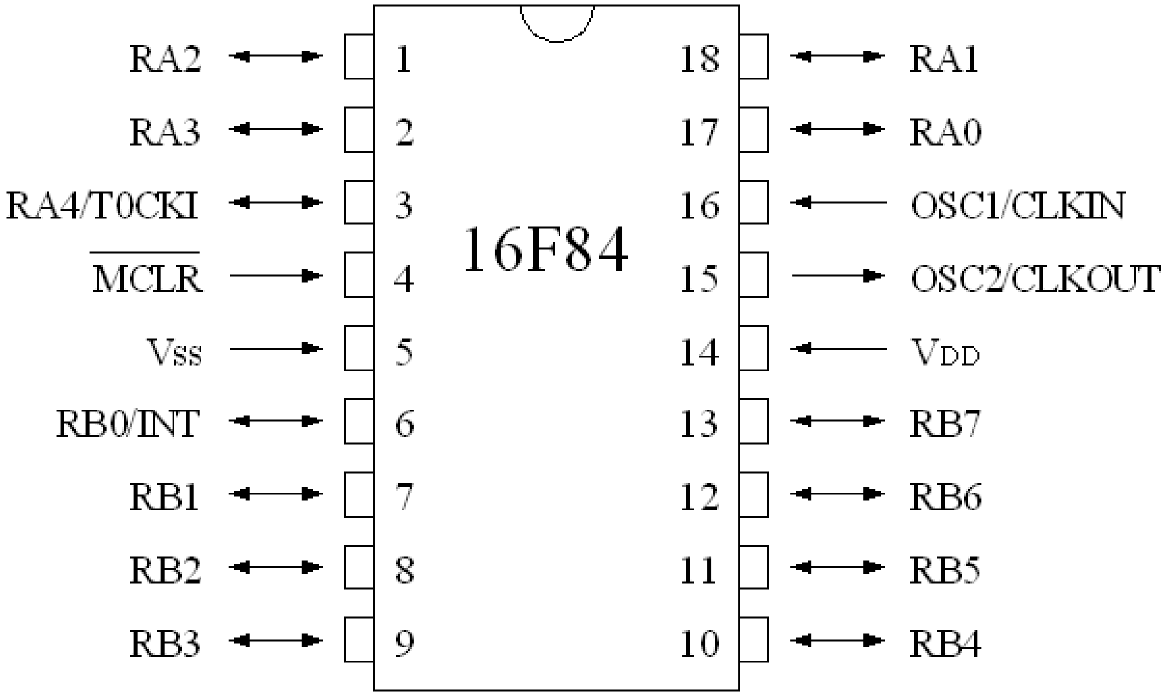


Figure:03

2.5PIN Description of PIC16F84:

Pins on PIC16F84 microcontroller have the following meaning:

Pin no.1 **RA2** Second pin on port A. Has no additional function

Pin no.2 **RA3** Third pin on port A. Has no additional function.

Pin no.3 **RA4** Fourth pin on port A. TOCK1 which functions as a timer is also found on this pin

Pin no.4 **MCLR** Reset input and Vpp programming voltage of a microcontroller

Pin no.5 **Vss** Ground of power supply.

Pin no.6 **RB0** Zero pin on port B. Interrupt input is an additional function.

Pin no.7 **RB1** First pin on port B. No additional function.

Pin no.8 **RB2** Second pin on port B. No additional function.

Pin no.9 **RB3** Third pin on port B. No additional function.

Pin no.10 **RB4** Fourth pin on port B. No additional function.

Pin no.11 **RB5** Fifth pin on port B. No additional function.

Pin no.12 **RB6** Sixth pin on port B. 'Clock' line in program mode.

Pin no.13 **RB7** Seventh pin on port B. 'Data' line in program mode.

Pin no.14 **Vdd** Positive power supply pole.

Pin no.15 **OSC2** Pin assigned for connecting with an oscillator

Pin no.16 **OSC1** Pin assigned for connecting with an oscillator

Pin no.17 **RA2** Second pin on port A. No additional function

Pin no.18 **RA1** First pin on port A. No additional function

2.6 Infrared LEDs

LEDs are surely one of the most commonly used elements in electronics. LED is an abbreviation for 'Light Emitting Diode'. When choosing a LED, several parameters should be looked at: diameter, which is usually 3 or 5 mm (millimeters), working current which is usually about 10mA (It can be as low as 2mA for LEDs with high efficiency - high light output), and color of course, which can be red or green though there are also orange, blue, yellow.... LEDs must be connected around the correct way, in order to emit light and the current-limiting resistor must be the correct value so that the LED is not damaged or burn out (overheated). The positive of the supply is taken to the anode, and the cathode goes to the negative or ground of the project (circuit). In order to identify each lead, the cathode is the shorter lead and the LED "bulb" usually has a cut or "flat" on the cathode side. Diodes will emit light only if current is flowing from anode to cathode. Otherwise, its PN junction is reverse biased and current won't flow. In order to connect a LED correctly, a resistor must be added in series that to limit the amount of current through the diode, so that it does not burn out. The value of the resistor is determined by the amount of current you want to flow through the LED. Maximum current flow trough LED was defined by manufacturer. High-efficiency LEDs can produce a very good output with a current as low as 2mA.

LEDs are connected to a microcontroller in two ways. One is to turn them on with logic zero, and other to turn them on with logic one. The first is called NEGATIVE logic and the other is called positive logic. The above diagram shows how they are connected for positive logic. Since positive logic provides a voltage of +5V to the diode and dropper resistor, it will emit light each time a pin of port B is provided with a logic 1 (1 = HIGH output). NEGATIVE logic requires the LED to be turned around the other way and the anodes connected together to the positive supply. When a LOW output from the microcontroller is delivered to the cathode and resistor, the LED will illuminate.

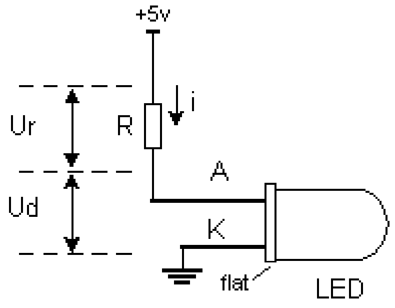
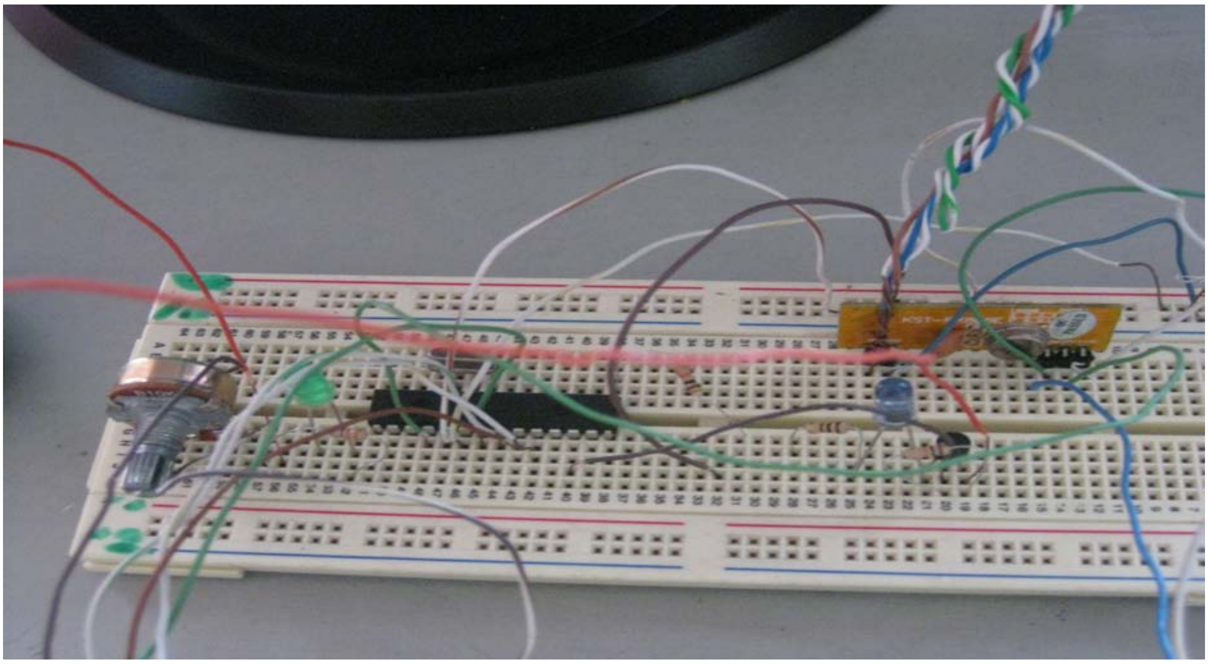


Figure: 04



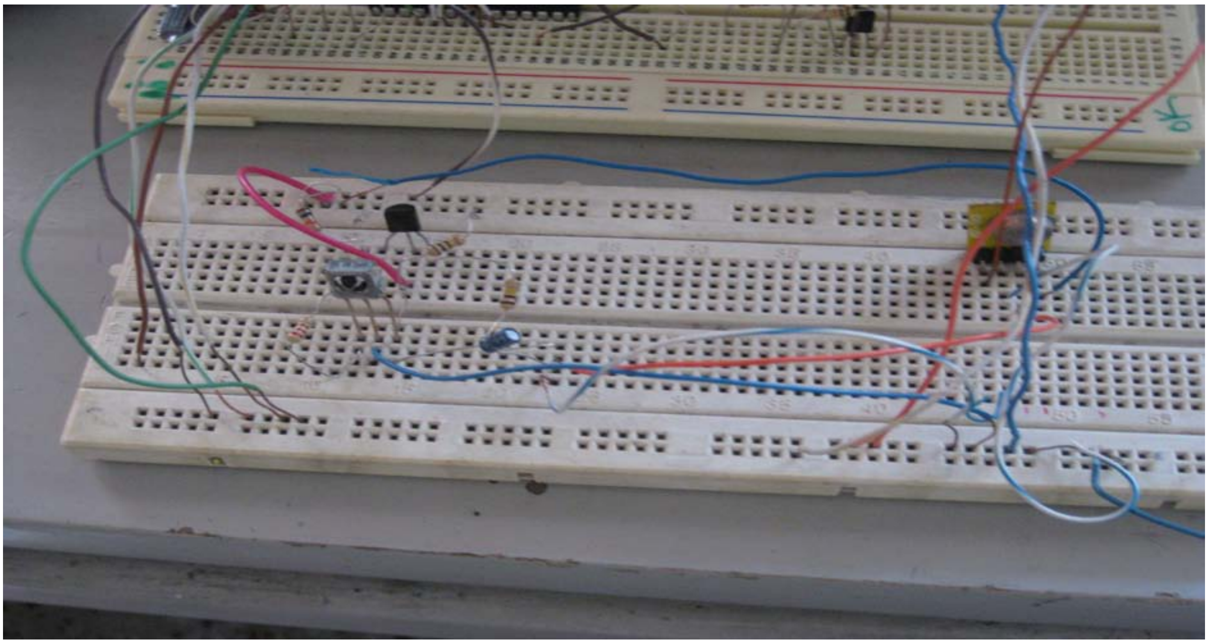


Figure: 05

3.Infrared Receiver & RF transmitter Operation:

When you aim your existing infrared remote control transmitter at the circuit shown below in Figure #6, and press a button, it transmits the IR signal to the IR detector. The IR detector modules data output pin, (marked OUT) in Figure

#1 outputs a low-going signal, which connects to the base of the 2N3906 PNP transistor turning it ON.

The output of the PNP transistor connects the RF transmitters DATA input to logic 1 causing it to transmit an RF carrier. When no data is being received at the IR detector, its OUT pin returns to logic 1, and the PNP transistor & RF transmitter module are both OFF.

In simple terms, when you press a button on your IR transmitter, the RF module emits a carrier. When you release the button on your IR transmitter, the RF carrier is turned OFF. Simple enough, but there's more - so read on.

So only incoming data from the IR transmitter turns ON the RF transmitter. This re-creates the same signal the IR transmitter is sending, but now the signal is RF, which can go through walls, ceilings, etc, and no longer requires line-of-sight.

If you have one of the circuits in Figure #1 in each room of your house, and one receiver circuit like in Figure #2 in front of the equipment you're controlling, you can control the equipment from pretty much anywhere in your home, and even from outside in the backyard.

I control the stereo in our living room from outside in my backyard, through the walls, and everything else in between.

It's pretty handy when your system is in a cabinet too. Just plop the receiver inside the cabinet, and place the transmitter wherever it's most convenient, and away you go. No need to drill holes in that expensive cabinet.

And, yes, I am aware that we can simply buy something like this off-the-shelf, but where's the fun in that? And how much control do you have over it?

Most off-the-shelf, manufactured units, aren't portable either. With this one, you can build the transmitter circuit in a very small package, something close to the size of a pack of cigarettes, it runs on 2 small AA batteries, and it's very portable.

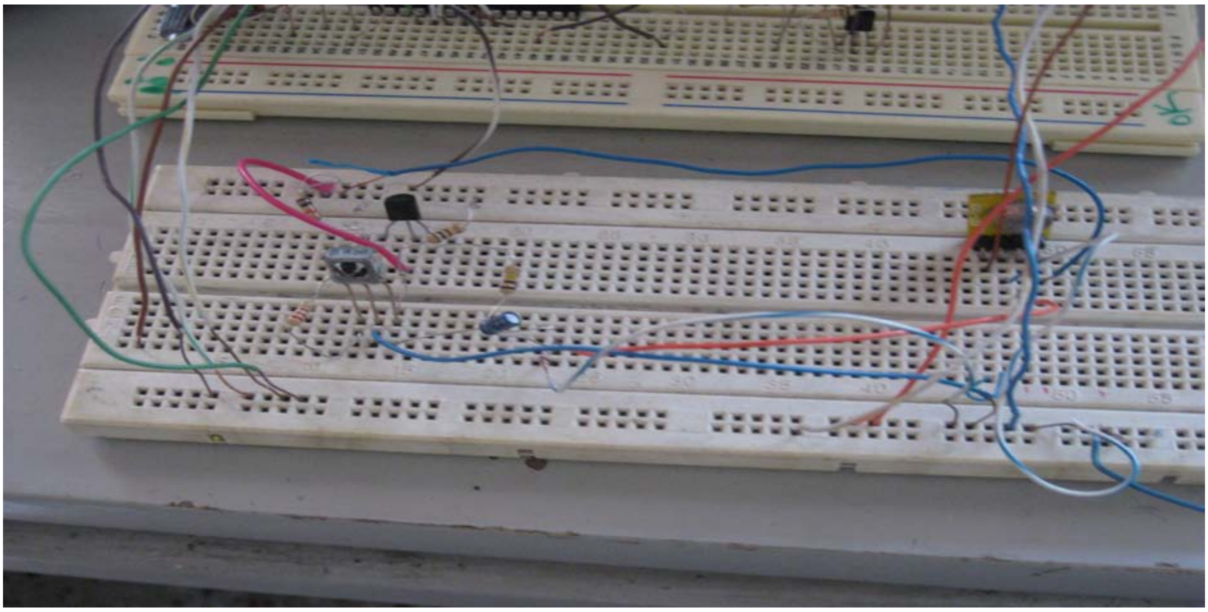


Figure:06

Note that this new version uses 2 AA batteries in series for 3 volt operation. Using 2 small batteries makes it much smaller, and requires fewer components, so a very small circuit board could be produced.

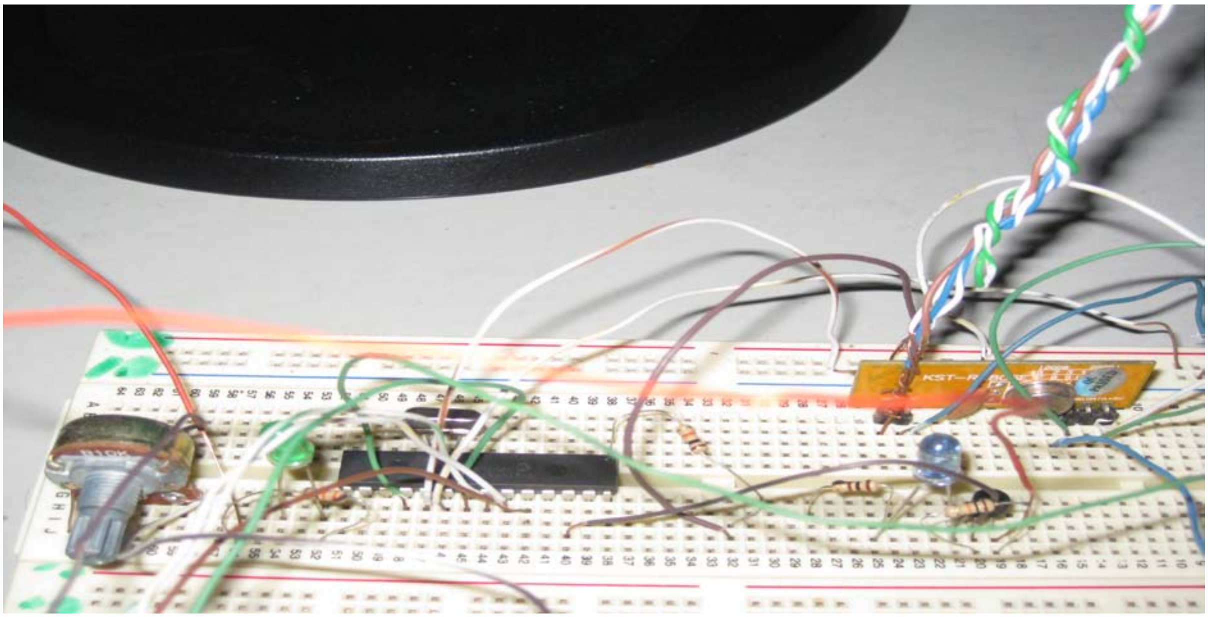


Figure : 07

3.1 The RF Receiver & IR Transmitter Circuit:

This one's a little trickier than the original project that used the older Linx LC receiver since the newer LR series data output pin will emit random noise pulses when there's no active RF transmitter carrier.

To deal with this, we're now using a different PIC microcontroller with built-in comparators. The CMVin+ pin is the + comparator input. This connects to the Linx LR series receiver RSSI (Received Signal Strength Indicator) pin, and a filter circuit consisting of the 1MΩ resistor and 0.1uF capacitor.

The RSSI output normally will idle (when no RF carrier is present) at around 1.5V. When the RF transmitter is active, the RSSI output level will increase.

The potentiometer connects to CMVin-, and is used to set the IDLE threshold voltage. Apply power to the receiver circuit, with no active transmitters in range, and adjust the potentiometer until the GREEN LED on COUT turns OFF.

The voltage on CMVin- should be just a few millivolts higher than the voltage applied to CMVin+ from the receivers RSSI output. Now, when the RF transmitter turns ON, the RSSI output voltage will increase, and trip the comparator output on COUT. The code waits for COUT to be at logic 1, which indicates the receiver is receiving a good strong RF carrier, and it looks at the RF receivers inbound data signal on GP3.

The filter circuit with 1MΩ resistor and 0.1uF cap helps filter pulses on the RSSI signal when the RF transmitter carrier turns ON/OFF quickly when re-creating the IR signal. I.E. in between logic 0 and logic 1 IR bursts. This provides a nice stable analog signal into the comparators CMVin+ pin, and it will quickly stabilize back to the idle voltage level close to approximately 1.5V when the RF transmitter ends its transmission.

The GREEN LED should only be ON when the RF transmitter is ON. It should be noted that any RF signal in the receivers range on a similar frequency will cause the RSSI signal level to increase. This should not be a problem however since the PIC code looks for the comparator to trip & data signals, so any false output from the IR LED will be garbage, and should have no affect on the equipment you're controlling. We beat up on this one pretty hard, and it works exceptionally well. And by simply adjusting the POT on CMVin- it's easy to tune out unwanted interference in the same frequency range.

We have now turned our incoming RF data back into a modulated IR signal, and have an IR remote transmitter we can use from pretty much anywhere in the house for our stereo, TV, CD players etc.

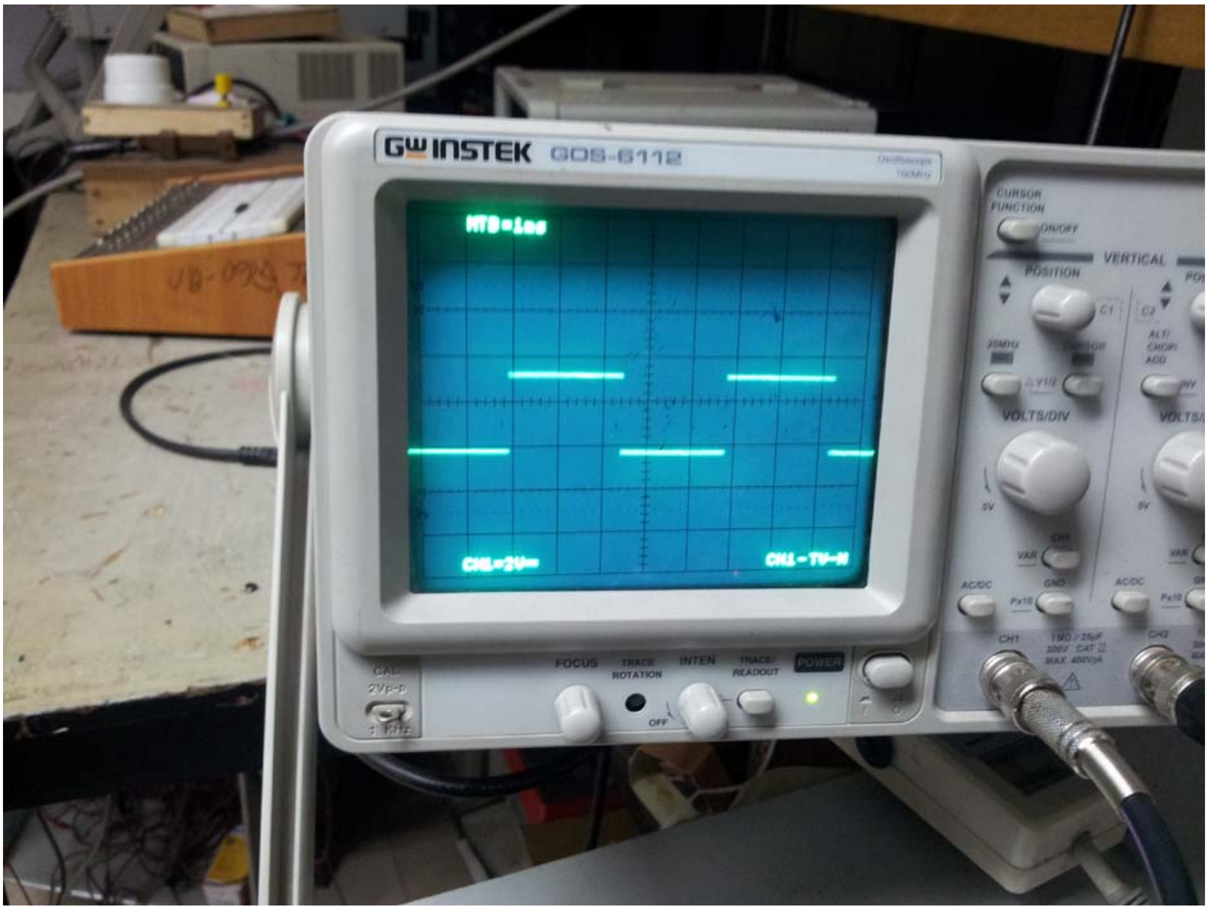


Figure: 08

3.2 Transmission results: The circuit we designed was tested in lab. The transmission circuit worked properly. The IR sensor sensed the signal and it send that signal to the data point of the transmitter (TX). Till this point the square wave. As we could not measure the delay of the circuit we could not actually measure the actual voltage of the points of transmitter circuit. We built two additional antennas for smooth progress of transmission for both Transmitter (TX) and Receiver (RX). The receiver received the transmitted signal properly. But the received signal strength was fading continuously. We could not stop the fading. We tried to maintain the purity of the transmitted and received signal and we became successful in doing that. The Microcontroller PIC16F84 also worked properly. The overall performance of both circuits were satisfactory. The final output is shown below.

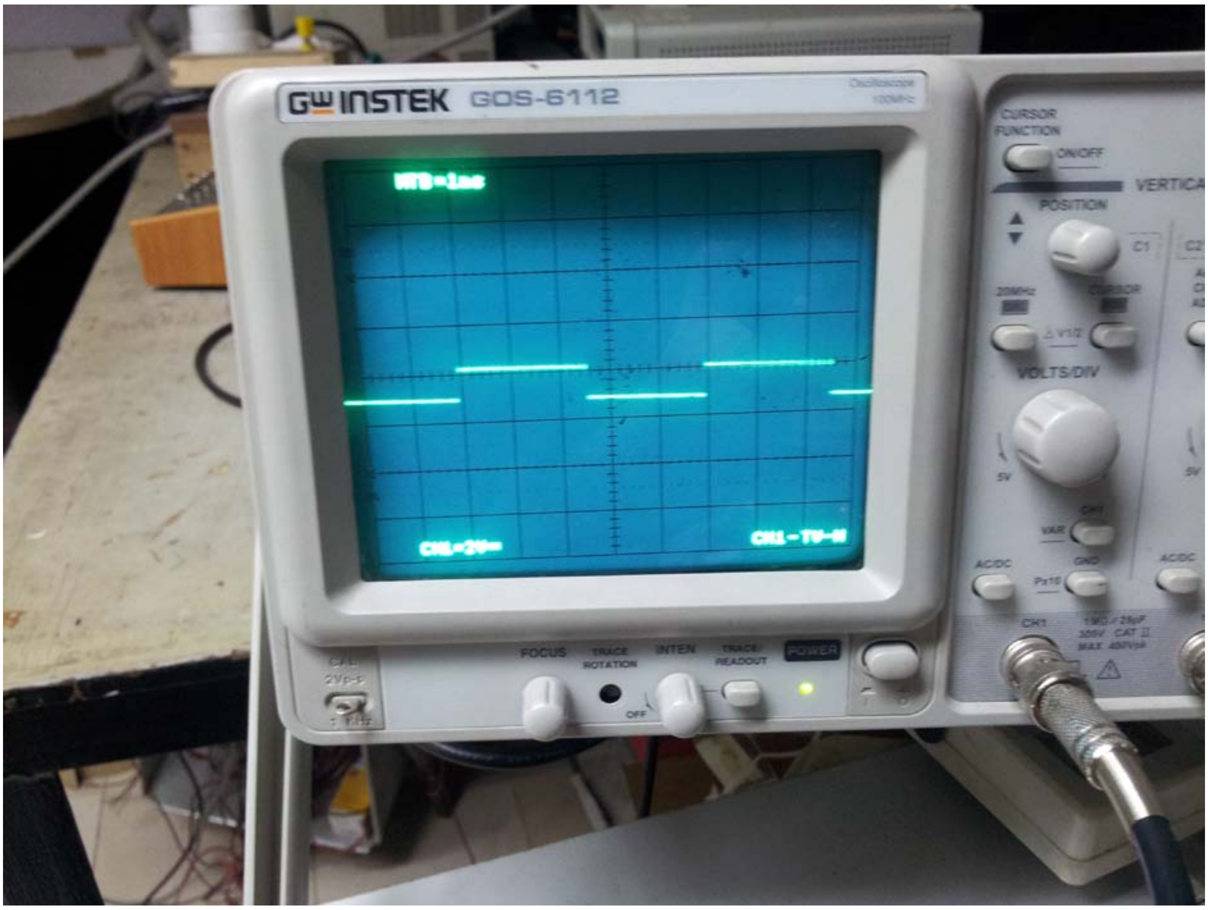


Figure: 09

From the above picture we can clearly see that though we received a square wave at the final output point of the receiver circuit the most part of the signal is lost on the way. To solve this problem we are planning to use an amplifier which will increase the strength of the signal.

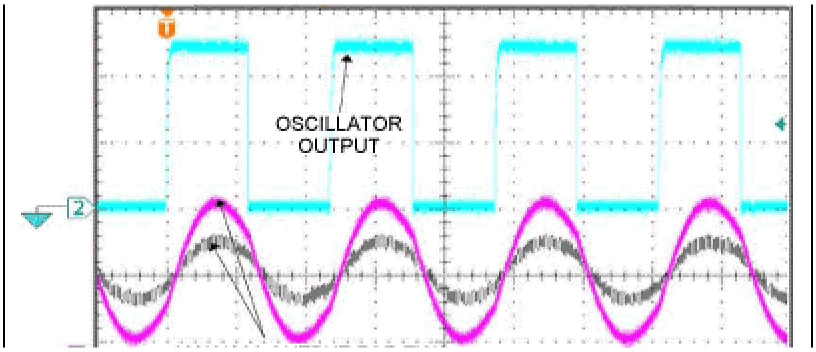


Figure: 10

In figure: 11 the wave shape in black is the IR signal at the output point and the signal in violet is the amplified signal. After passing the amplified signal through an oscillator we can have the desired amplified square wave.

4. Future Plan

Figure: 11

4.1 The Radio Transmitter Control Box

Transmitters send radio waves or electromagnetic frequencies to an RC car or other remote controlled device. The operator moves the controls on his remote control radio. The transmitter talks to the receiver via the radio carrier wave. This in turn drives the motor. A large variety of radio controllers are available on the market, and although these mostly operate on the same principles, choose the style for gripping, holding, and maneuvering that is most comfortable for you.

4.2 Receivers

The receiver can be a circuit board with internal antennas or a larger antenna on the exterior of the remote controlled car. The receiver is the interpreter for the motor. Any radio signals coming from the transmitter end up at the receiver. The receiver then converts these signals for the servo motor.

4.3 Motors

The motor is the strength of the remote controlled car. Motors control wheels, propellers, or other oscillating parts. A motor is the part of the remote controlled car where energy from the power source is converted into mechanical work. This mechanical work increases or decreases electrical activity to electric powered RC cars. The motor is really nothing more than a go and stop mechanism. In more advanced RC cars, this motor may have three gears or more. The latter type of RC car motor is part of a miniature transmission system, and is useful for rugged and off-road terrain.

4.4 Power source

Power sources for remote controlled cars range from batteries to gasoline. Other than the power source, most remote controlled cars function the same. The choice of appropriate power sources depends on the design of the remote controlled car, as well as the terrain the operator wishes to run the RC car over.

The circuits shown in the Figure: 11 are the circuits of a remote controlled toy car. I studied the circuits of the toy car carefully. The circuit of the toy car consists of two parts. They are- (i)Transmitter circuit and (ii)Receiver circuit.

Transmitter circuit: The transmitter circuit of the toy car is consists of Transmitter (Tx), Crystal Oscillator, LED, Joy stick(to control car's direction and speed), Resistor, Antenna. To make this circuit work we need a power source of 3 volt.

Receiver Circuit: In the receiver circuit there are Receiver (Rx), 2 capacitors, 4 n-p-n transistors, resistor and antenna for receiving transmitted data. This receiving circuit is connected to the both front and rear motor of the car. So that it can perform commands received from the transmitter.

5. APPLICATION

The application of my circuit will have a great effect on our day to day life. it will increase human effort and will save our time. We can apply this circuit to toy car, car keys, Helicopter (Which can be used for traffic and security surveillance), robots , In industries where its difficult to do jobs by human. With the help of this circuit the existing remote control system will be able to transformed to above technology easily. With this remote control we will be able to control electronic devices such as, TV, DVD player, refrigerators, AC and so on. Moreover this remote control can penetrate concrete wall, So line of the sight of the end device will not be needed.

6. Conclusion

After studying the both circuits of the remote controlled car I found a lot of similarities with the circuits I designed. I can easily modify the circuits of the toy car and apply the circuit I designed. Not only toy cars then we will be able to apply this circuit to all electronics equipments like TV, Toy helicopter (which can be used for traffic updates and security surveillance), robots etc. As the circuit has the ability to penetrate concrete walls we can use the remote to control equipments from a distance of 150 feet. The equipments I used can work in extreme conditions like sub-zero temperature and 50 degree Celsius. These equipments are easily available and cost effective. Normally all the remotes used in electronic devices use IR signals. As a result the range of the remote control is at best 10 feet. After applying the circuit I designed the range not only will increase but also the performance of the remote control will be better and handy. It will decrease human effort and will save a lot of time.

7 References:

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