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An AC Wireless Remote Control System

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Abstract

The aim of this research is to design a multi-job control system for controlling on different job on home or office by using a simple scientific technique. Making more holes on walls of home to connect a wire or control cable for any job does not desired.

The research is aiming to design a wireless control system. This control system can send any command to any device in the home or office without making any more holes in walls.

This research depends on using the 220 VAC 50 Hz wires, which had been provided in home or office. The frequencies used to control the devices will be carried by the 50 Hz current used in home. These frequencies have been chosen between 30-110 kHz, and we can use (8) channels in this band to prevent interference of commands. The wireless control on the devices will be done by using a PC computer and simple BASIC program. ON-OFF command can be sent by the operator to any device by a transmitter built and interface with that compute.

Key Words: Wireless Remote Control, (UART: Universal Asynchronous Receiver-Transmitter), (SCR: Silicon Controlled Receiver), Transmitter, Receiver, Filter, Frequency.

منظومة سيطرة لاسلكية باستخدام التيار المتناوب

الخلاصة

تم بناء منظومة سيطرة متعددة الإغراض للسيطرة على تشغيل وإطفاء أجهزة منتخبه عن بعد في بناية ما، باستخدام التقنيات العلمية. تم إعداد هذا التصميم لبناء منظومة سيطرة لاسلكية تستطيع توصيل أوامر التحكم لأي جهاز في البناية من دون إضافة تسليك أو ثقوب قي الجدران ، وذلك باستغلال التيار الكهربائي 220 VAV 50Hz المستخدم وتحميل هذا التيار بترددات التحكم الخاصة وبحزمة ترددات تتراوح بين 30-110 kHz ومن الممكن انتخاب (8) قنوات ضمن هذه الحزمة لمنع التداخل بين الأوامر . يتم تحميل الترددات الخاصة بأجهزة التحكم وإرسالها ضمن التردد 50 Hz ومن ثم استقبالها بأجهزة استقبال مربوطة على التيار للأجهزة المراد السيطرة عليها.

يتم التحكم باستخدام الحاسب الآلي ، ويتم تجفير الأوامر (فتح) أو (غلق) عبر برنامج مكتوب بلغة برمجة ينفذ عن طريق الحاسبة وإرسال ذلك عبر مرسله وبحزمة معينة بحيث يمر أمر تشغيل أو إطفاء أي منها من خلال (مرشح) خاص بكل تردد دون إن تتأثر بقية الأجهزة بهذا الامر 0 كما يمكن إن تتم عملية السيطرة اللاسلكية على عمل الأجهزة أوتوماتيكيا من خلال برمجة الحاسبة المستخدمة.

الكلمات الدالة: السيطرة اللاسلكية عن بعد، التزامن الكلي للمرسلة – المستقبلة، مستقبلة بالسيطرة السليكونية، المرسلة، المستقبلة، المرشح، التردد

Introduction

Many experiments have graduated from the use of computer strictly for games and are now wiring more sophisticated programs. They may do accounting, music, composition or straight number cruncher program, but the key is evaluation. The concept of the home management system is fine, but it is bound by the system peripherals [1,2].

The basic logic flow of any computer system is: input, process and output. The computer accepts data input, processes them with a fixed routine called a program, and output the results. These results may be an alphanumeric response as a video display that allows the operator to access this processed information, or logical results such as YES or NO or may be ON or OFF. In the later cases the signal logical, ON or OFF value can also be used to control some devices. A typical example is a furnace circulator pump. Temperature information is entered to the computer, which decides whether the heat is too high, in which case the pump should be OFF, or too low, in which case the pump should be ON. This condition should be displayed on an operator console, instructing the operator to physically turn the pump ON or OFF, but it mould be far more efficient if the computer perform the action as well as calculate the decision.

The concept of the computer control is as old as computer itself. Process control and data acquisition are the major applications of industrial computer. While the computer structure might be similar, the logistics are quite different.

In the home application, even though the wiring cost might be less, the idea of stringing wires all over the house is abhorrent to the most of us. No one wants to punch holes in the walls.

The easiest alternative is wireless control. Such an approach uses the existing 220 VAC house wiring for both control power and signal transmission. This method is most cost effective in limited applications being controlled are not article [3,4].

Figure 1 shows the block diagram of wireless AC remote control system. An AC transmitter modulates the existing house wiring with high frequency signals. These signals are detected by special receivers which plug into any AC receptacle. Appliance or other electrical devices can be plugged into the receivers and controlled a dedicated control computer. The setup shown is one of the applications for a 5 receiver systems. Applications include turning house lights on and off during the user's absence, automatic shut down of various devices.

Description of the system and design

Carrier Current System:

Generally speaking the carrier current method transmits a high frequency carrier (30 kHz to 500 kHz) similar to a standard radio transmission into the house wiring. It is superimposed on the 50 Hz, 220 VAC line signal and is broadcasted through the house (or office). This transmitted carrier can be modulated to send music or digital information. In limited ON and OFF control applications, though, the more presence or absence of the carriers' frequency is used to provide the control logic. The use of modulated or demodulated system depends ultimately on the numbers of parameters to be transmitted. If only one output to be controlled and it is going to be ON or OFF (such as a desk lamp), a single frequency can be used. Detecting of the frequency of transmission at the receiver turns the light ON, and its absence turns the light OFF[5,6].

Controlling two outputs requires two separate frequencies, one for each channel, and additional logic must be added in the receiver if the appearance of simultaneous output control is required. In case where more than 20 channels are to be controlled or multiple settings are required at each control point, modulated transmission are best employed. An example of this would be 256 position level switches in some remote locations. Rather than attempting to use 256 separated frequencies, a signal frequency can be modulated and used to transmit an 8 bit code to the receiver. This similar in format to serial data presently used on cassette interfaces. The only difference is that the serial data stream is transmitted on as high frequency carrier and detected in a receiver before being converted for use. This method should only be considered for extensive communications, since it is relatively expensive and receivers are more complex.

The major consideration one should take when looking at a carrier current control system is the ultimate number of discrete points to be controlled. An output channel is defined as a single bit; i.e a 4 channels system would consist of four ON/OFF control elements. In a single channel system, the simplest carrier / no carrier method is normally employed [7].

For systems with the capability of 2 to 10 channels, multiple frequencies with latching logic are considered. In cases where minimum number of channels is 16, modulated carrier with serial data transmission is advised. There exists a gray area between ten channels and 20 channels. Both multiple frequency and serial data can be used in this range, but the cost difference must be considered.

Carrier current control methods

There are four carrier current transmission methods that can be used on the standard home (or office) computer system[4,7]:

<u>1- Single Channel ON / OFF:</u>

Usually a height frequency carrier is transmitted through the house wiring. A tuned receiver turns ON when the tone is transmitted, and the OFF when not.

<u>Advantages</u>: Cheep.

Disadvantages: One channel only. Tone transmitter must remain on for output to remain ON.

<u>2-Multiple channels multiple frequencies:</u>

Generally speaking, two height frequency carrier current signals are usually not transmitted simultaneously if they are from separate channels. The AC line is quite noisy and not exactly the best antenna. To avoid harmonics which could trigger unaddressed channels, unique frequencies are used for each channel. In multiple channels arrangement, no single channel is continually addressed, so method must be incorporated to latch the logic output.

The multichannel methods are seen most often utilized pulses transmission. A particular receiver's frequency is pulsed once or twice within a timed window. One pulse means "ON", two means "OFF". The desired control output is latched into a flip-flop in the receiver.

<u>Advantages</u> Relatively inexpensive. About 20 different channels can be accommodated within transmission bandwidth of 100 kHz. Only a one frequency receiver is required for one receiver.

***Disadvantages*:** Pulsing the latch ON or OFF requires external gating logic in addition to a tuned receiver, multiple channel arrangements require considerable inter channel decoupling and narrow receiver bandwidths. Depending on particular logic design, this can be accurately timed either a hardware or software, while conceptually simple, requires considerable additional circuitry to make it glitch proof.

3-Multichannel Multifrequency Dual receivers:

This method is essentially the same as the previous one except that separate frequencies are used to turn the controlled output ON and OFF. Either method would utilize the same transmitter[2,5].

Advantages: since separate frequencies are used for the set and reset functions, special constrain on timing are eliminated. Long time-constant input filtering techniques can be used to reduce glitches. No special software is necessary to drive the transmission device. This method combines the best features of method 1 and 2.

Disadvantages: Decreases the total number of possible control outputs, since two separated frequencies are required for each channel that can be can fit in a 100 kHz bandwidth.

4-Single Frequency Asynchronous Data Transmission[7].:

This type of carrier current transmission system can be used to transmit serial data rather than a discrete control signal which is ON or OFF.

This data when received and decoded, can be effectively used an extension of the pulse window transmission concept stated earlier. Finer filtering methods are required trough, since timing is more critical.

***Advantages*:** A single frequency system can allow as many as 128 controlled output in a single frequency for each 8 bit data word.

***Disadvantages*:** Expensive. Transmission is serial and each receiver must incorporate logic for serial to parallel conversion, usually in the form of a universal asynchronous receiver-transmitter (UART) or its equivalent.

Access to Design:

Most likely, any experimenter interested in constructing a carrier current control system will want to start with one or two channels. In our own case we can see expansion to may be eight channels. The most cost effective approach for us is to use either system 2 or 3 described above. The multi-frequency pulse transmission method, has in our design, been proved to be too unreliable in practice. Reliability is gained at the expense of considerable extra circuitry.

Automatic control operation of home appliance and lights, reliability is essential. For this reason this design relies on the use of two frequencies for each channel. One is used to turn the device ON and other is to turn it OFF. These frequencies will be grouped in pairs and referred to as a single channel. The bandwidth of each channel is about 8 kHz. In practical terms this means that, if the transmitter has a total frequency range of 30 kHz, then 80 kHz divided by 8 kHz equal 10 independent channels. Within this 8 kHz band two separate frequencies are allocated. One turns the device ON while the other turns OFF.

In the example illustrated in this research, channel 1 occupies 35 kHz to 43 kHz. The ON-OFF frequencies are 35 and 39 kHz respectively. The next channel 2 occupies 43 to 51 kHz and the ON,OFF frequencies are 43 and 47 kHz respectively. There is no magic strategy for picking frequencies. Each remote receiver detects two frequencies 4 kHz apart. The only consideration is that all receiver frequencies be separated by at least 4 kHz. The fewer the channels the further apart these frequencies can be. In a 2 channel system, choosing widely separated frequencies is safest. Channel 1 could occupy the band 35 kHz to 43 kHz and channel 2 the band between 83 kHz and 91 kHz (and transmit on 83 kHz and 87 kHz). Apportioning bandwidth to maximize, the number of channels is a major consideration in a multi-frequencies system. (Receiver will be described later).

Figures 4-a and 4-b show the schematic diagram of the AC remote transmitter. It consists of a digitally programmable frequency source and an optically isolated house (office) wiring driver.

The components of programmable frequency generator, IC1, IC2, IC3, IC5 and IC6, form a precision voltage controlled oscillator. IC1 is an 8 bit digital to analog converter, whose output current is proportional to 8bit data word impressed on its input lines. The current output is converted to a voltage through IC2 and presented to the input of IC3, voltage controller oscillator (VCO). Its output frequency is proportional to input voltage. Analogue frequency sources such as this are usually avoided because of stability problems. The alternative involves programmable divided by N counters and a crystal frequency input, which would mean about 25 integrated circuits to produce the same range of selected frequencies.

Therefore, it is important to overcome potential problems. The major error producing components in such designs are usually the voltage references and oscillator timing elements. By using a precision voltage reference circuit, IC5 and IC6, (shown in figure 4.b) and incorporating polystyrene low drift capacitors in the voltage controlled oscillator section, these problems are virtually eliminated.

The resulting circuitry is a digitally programmable oscillator. With the values chosen, the rating is about 30 kHz to 110 kHz. Changing the output frequency is simply a matter of changing the code on the digital to analog converter. Within the 80 kHz range of the voltage controlled oscillator, there will be 256 discrete increments of frequency, presuming that the input and output that characteristics are linear, and each increment would be 80000/256 or approximately 300Hz. This mean that, if a digital input code of binary 0000000 produces an output of 30,000 Hz, then octal 00000001 would be 30,300 Hz. Further extrapolation gives an output frequency of 49.2 kHz for a binary 01000000 (decimal 64). Voltage controlled oscillator is non-output linear but the output frequency may be set, by using a simple BASIC program.

Once the oscillation frequency has been produced, the next problem is to transmit it through the house wiring. This transmitter section consists of IC4, Q1, Q2 and Q3. The oscillator output is optionally isolated and coupled to the output driver stage of through IC4. The three transistors form a power amplifier and pump about 0.5 watt onto the AC line.

The amount of power is sufficient to reach all areas of the house and few next door neighbors, but there should be no interface with any house hold appliance.

We must think to separate this location from other houses because of the sharing of 220VAC with them. Also, the output driver must be isolated from the computer, it can not use the computer power supply as its power sources, so components D1,D2 and T1 form a voltage detection fault, and provide approximately ±13v to run the driver. It is important to note that there are two separate grounds in the circuit. One is the computer ground and the other is the driver circuit ground. They are not to be connected together.

Building and Testing the Transmitter

It is necessary to build the receiver to complete the test of the transmitter, without oscilloscope usage, to make sure everything is correct. Certain shortcut methods can be employed this time, to give us reasonable confidence about the circuit operation.

The circuit given in figure 4.b has been designed, firstly the drive circuit and IC4. Then, we add a 0.1µFcapacitor in parallel with 0.005 µF capacitor betweens pins 3 and 4 on IC3. This will effectively lower the output frequency range of the voltage controlled oscillator into the audio range. By putting a 100Ω resistor between IC3 pin6 and an earphone whose other terminal is connected to ground, this audio tone can be heard. It is a simple matter to change the tone. The astute experimenter will realize that we have constructed a programmable tone generator, possibly suitable for music application.

Use BASIC Program to Run the Controller

Based on the above mentioned design feature, the design may be driven by a latched parallel output port and update speed is of no particular importance. It is obvious that a simple programming language, like BASIC, can do the job, which set 8 bit output ports. The interface controller can be set to any frequency within its range under program control. BASIC program can also perform a simple test to determine whether the voltage controlled oscillator works. The BASIC program (to be build for this purpose) causes the output frequency of the voltage controlled oscillator to ramp up in a roughly linear fashion and reset. With the capacitor values, as given in the schematic diagram, the range should be approximately 30 kHz to 110 kHz. Again, picking any larger capacitor value will allow this saw-tooth tone generator to be heard in the audio range. Actual control of a device comes after the receiver section has been built and added to the complete the overall circuit design. A BASIC program can be build to control to the channels. This program can drive two remote control channels by the key board.

Input Filter and Power Supply

Each receiver, designated as a single channel, received two transmuted frequencies from the computer. One is used to turn the AC device ON and the other to turn it OFF. These two tones must be closed enough to be passed through the same filter section but not enough to interface with each other. For this reason, a channel bandwidth has been designated to be 8 kHz, and no two tones are closer than 4 kHz. The function of the input filter is to reject the 50 Hz line frequency and all other frequencies except the 8 kHz band of a specific channel. While this may appear true in theory, it is not quite the result. Instead, the amplitudes of various frequencies will be affected as they pass through the filter, 50 Hz will be virtually nonexistent, and if the pass-band is from 35 kHz to 43 kHz, that frequency range should be the highest amplitude, this amplitude variation across the spectrum can be facilitated somewhat by the addition of a tuned inductance and capacitance (LC) circuit, called a band-pass circuit[2,6].

The center frequency of the LC circuit should be set for the center of the particular pass-band desired. In the case of 35 to 43 kHz, the inductor and capacitor are choosing to produce a resonance at 39 kHz, the result is passive filter. As the RC section passes frequencies closed to 39 kHz, the LC computation starts (which increases the overall amplitude seen at the base of Q1). In practical a low Q slug tuned 1 to 10 millihenery coil set will work properly.

By using this LC circuit, the fundamental frequency of the transmitted waveform is sufficiently high in level to be differentiated from the second and third harmonics, which are also present. A sensitivity adjustment on the base of transistor Q1can be done, in the detection process by allowing only signals of sufficient amplitude through the next amplifier filter section of Q1.

The use of LC filter does require component value changes to cover the 30 kHz to 110 kHz range of the transmitter. Figure 5 is the schematic diagram of the LC combination in question and includes the formulae required to make this calculation.

Again, calculations are only part of the answer and are acceptable only in 2 or 3 channel applications. For optimum tuning the component values should be chosen according to the equation.

Then using an oscilloscope, measure the voltage across the LC circuit and slowly adjust the slug-tuned coil to peak at the desired frequency. A voltmeter on the AC setting will not respond sufficiently; only an oscilloscope with impedance inputs should be used. The power supply section is a standard rectifier and 3 terminal regulator supplies. The circuit requires less than 100 mA and values are not critical. The LM309 voltage regulator is the plastic TO-5 package version of the standard LM309K, which is a TO-3 metal, can be used and no heat sink is required[7].

- The solid state relay noted in the schematic can be 22RE1-541.
- Minimum current rating should be 6A.

1- All resistor 1/4 watt 5% unless other wise noted.

2- All capacitor are 100V ceramic unless otherwise noted.

3- The values of L and C in the tuned filter are computed for the practical center frequency chosen. In general L should be an adjustable slug tuned n a rang(see figure-3) e of 1 to 10 mH.

4- If this receiver is used on AC lines which also power many inductive devices such as motors and pumps, voltage surge protection many be required on the input.

5- A 7400 can be substituted for the 7437 if the set and reset LEDs are eliminated.

Tone Detectors

The hearts of the receiver are the two tone detectors IC1 and IC2. Each is tuned to a specific frequency or tone within its respective channel bandwidth. For the channel 1 frequencies chosen (35 kHz to 43 kHz), IC1 would be set for approximately 35 kHz and IC2 would be set at 4 kHz higher at 39 kHz. IC1 is considered the set frequency receiver and IC2 is the reset receiver. LEDs are attached to their outputs to facilitate tuning. These LED's will light only when the correct frequency is present at the respective pin3.

As with the input filter, these are tuned circuits and they required component value changes for the different channels. Figure-7 shows an individual receiver and outlines the equations used to select the value of the components. Values chosen are standard and could be set closer with the addition of trim pots, etc. In practice this won't be necessary unless all ten channels are to be constructed.

Output Latch

The outputs of the set and reset tone detectors go to the set and reset flip-flop made frame two NAND gates (IC3a and IC3b). If either the set pushbutton is pushed or IC1 receiver the proper signal, the flip-flop goes into the set state and the output device is activated. It will stay in the "ON" condition until the reset signal is received through IC2.

Although the 7437 is quite capable of driving a silicon controlled receiver (SCR) directly, turning ON a triac is a bit more involved. When the parts necessary to perform this function cost more than commercial solid state switch, it's time to go commercial. There are experimenters which used SCRs because they have, though .

Figure-8 is a schematic of an alternate 1000watt solid state relay. It is important to note that, while both the SCR and home brew device in figure-6 are optoisolated devices, the AC remote receiver itself is not isolated, and care must be taken when probing into a plugged-in unit. In this case, the only advantage of the optoisolator is that the required current to deliver the SCR or triac: a 7437 by itself may not SCR gate currents have a wide variation (1 to 100 mA for various SCRs does not have unlimited drive capability. For some less current consuming applications, a standard 7400 can be used instead of a 7437[7].

System Calibration, Verification and Testing:

There are two ways to calibrate this system, trial and error (good for one or two channels only), and using proper test equipment (necessary for three or more channels). The later is preferred and can be discussed here in after.

The first thing to do after building the transmitter is to determine what frequencies are being transmitted. Using the BASIC programs and a frequency counter attached to pin 6 of IC3 on the transmitter described previously will have 256 possible values but not all are required at this time. A program could be written to run slowly across all frequencies and stop when the receiver picks what up. This method involves trial and error, it is preferred to tune the transmitter to a known frequency, and then tune the receiver[2,5].

The transmitter and receiver are plug into the same wall socket initially. Using our program, we set the transmitter to continually transmit one tone in the center of a channel, such as for channel 1 (39 kHz).

Choose component values from figure-5 and adjust the coil slug until the maximum voltage appears across the LC circuit in the filter section. Reset the frequency transmission for the set frequency (35 kHz) and adjust the sensitivity pot until the LED at pin 8 of IC1 comes ON. Failure of the LED to light indicates any of the following:

1- Insufficient transmission amplitude: check transmitter output.
2- Wrong frequency transmitted or wrong components chosen for the receiver: check program action and recheck calculations.
3- Misadjusted sensitivity pot: attach scope to collector of Q1 and note that sensitivity pot turns signal ON or OFF.
4- Bad tone decoder.

Once this phase is completed, we set the transmitter frequency to the reset frequency (43 kHz) by entering the appropriate number when tuning the program. Then we check to set that the LED lights. The sensitivity pot may require adjustment.

The key is to find a setting that works for both set and reset frequencies simultaneously. The same procedure is repeated for any other channel.

This program can be rewritten as following algorithm steps.

Test Algorithm

1- Plug the transmitter and receiver into the same wall socket.

2- Run program which set transmitter to continually transmit.

3- Check such that one tone in the center of channel.

4- Is tone at 39 kHz ? if YES continue, if NO goto 2.

5- In figure 5, adjust coil slug unit maximum voltage appears across the LC circuit in the filter section.

6- Reset frequency transmission for 35 kHz.

7- Adjust sensitivity pot.

8- Check if LED pin8 IC1 ON, if yes continue, if NO there is a reason (must be checked).

9- Set the transmitter frequency to the reset (43 kHz) by software in our program.

10- Check for LED to be ON.

11- Adjust sensitivity.

12- Checking this channel for set and reset is complete.

13- Can you want to check other channel if YES goto (2) , if NO goto 14

14- End.

Applications (Using the System at Home)

The transmitter is plugged into any VAC outlet in the vicinity of the computer. Most homes have 220v service which consists of two independent lines. A frequency transmitted into the line may not pass over into another line with sufficient power to be detected at all receiver' locations. It may be necessary to take home of the receivers and plug it into a number of different outlets to determine which are in the correct circuit.

This potential problem is not unique with the particular design. In most cases, if there is sufficient 220 VAC load in use, such as heater and stoves, etc. The carrier frequency will pass easily through the loads from one line to other and the whole house will be covered.

The most obvious application of such computer control system is a home lighting system used in conjunction with a burglar alarm. The major problem with conventional time, activated light controllers is that their consistently repeated on and off periods are an immediate tip-off that no one is home. With this system and either a real time, time of day clock, or timing loop functioning as a clock, the ON and OFF period of a number of lights can be altered dynamically. The program which accomplishes this function can be implemented as easily in BASIC as any of the test program used to check out the AC remote controller.

Conclusions

In this study we can notes the following things:

1-we can use benefit of Ac wiring in the homes or offices to make wireless control on any device or job without making more holes on the walls of aims.

2-we can use the computer in our new live to make all our jobs in home or office, programmable.

3-Simple basic of electronics systems can be used to design benefit things in our live.

4-Low power supply is used for this job, (i.e. consuming of power is regarded in this study).

Suggestion for the Future Research

1-Our advisement is to make more study on this project with share of programmable engineer to make this job wise-used in Iraqi lives

2-We suggest to built a small prototype to achieve minimum and maximum design constraints.

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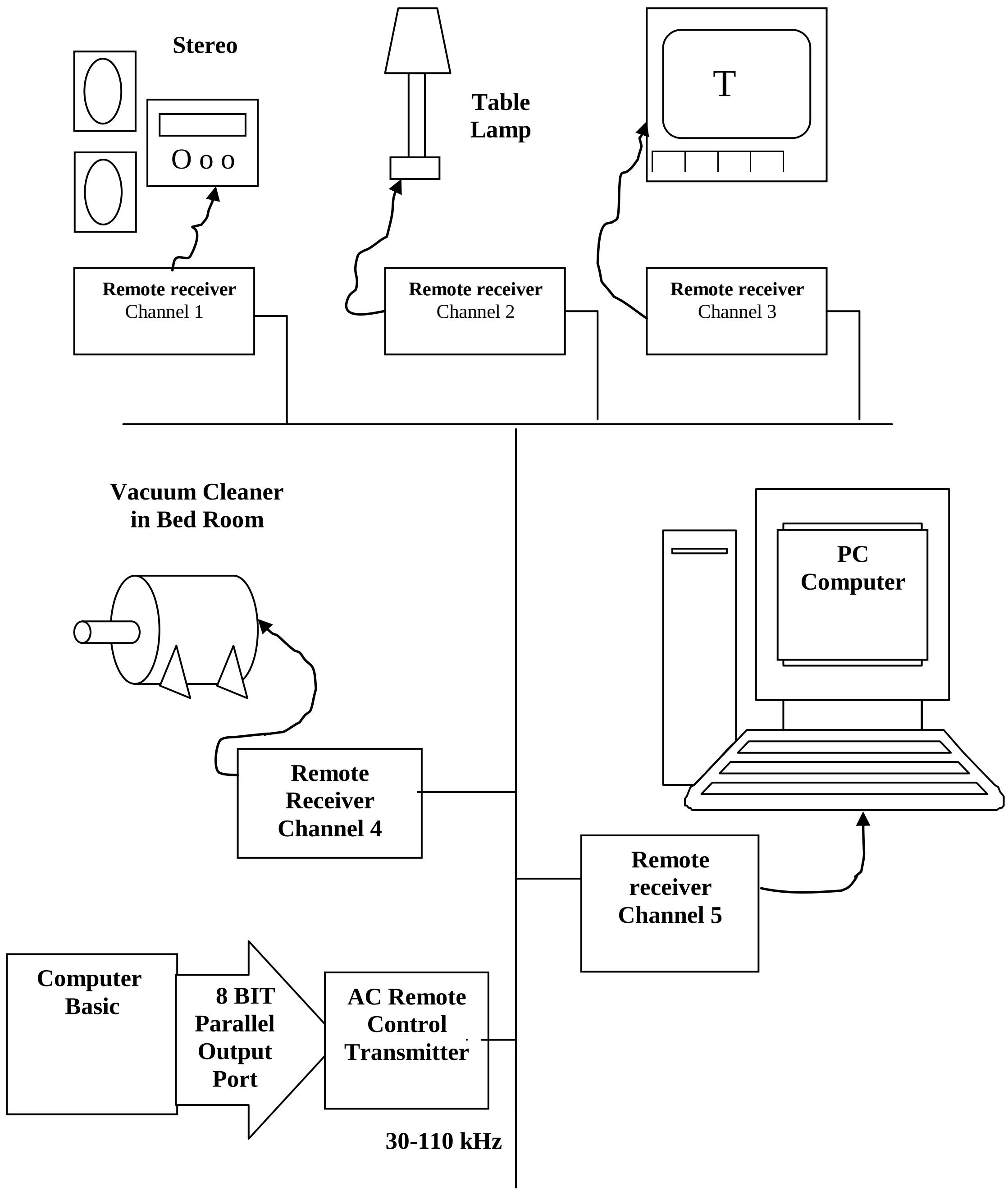
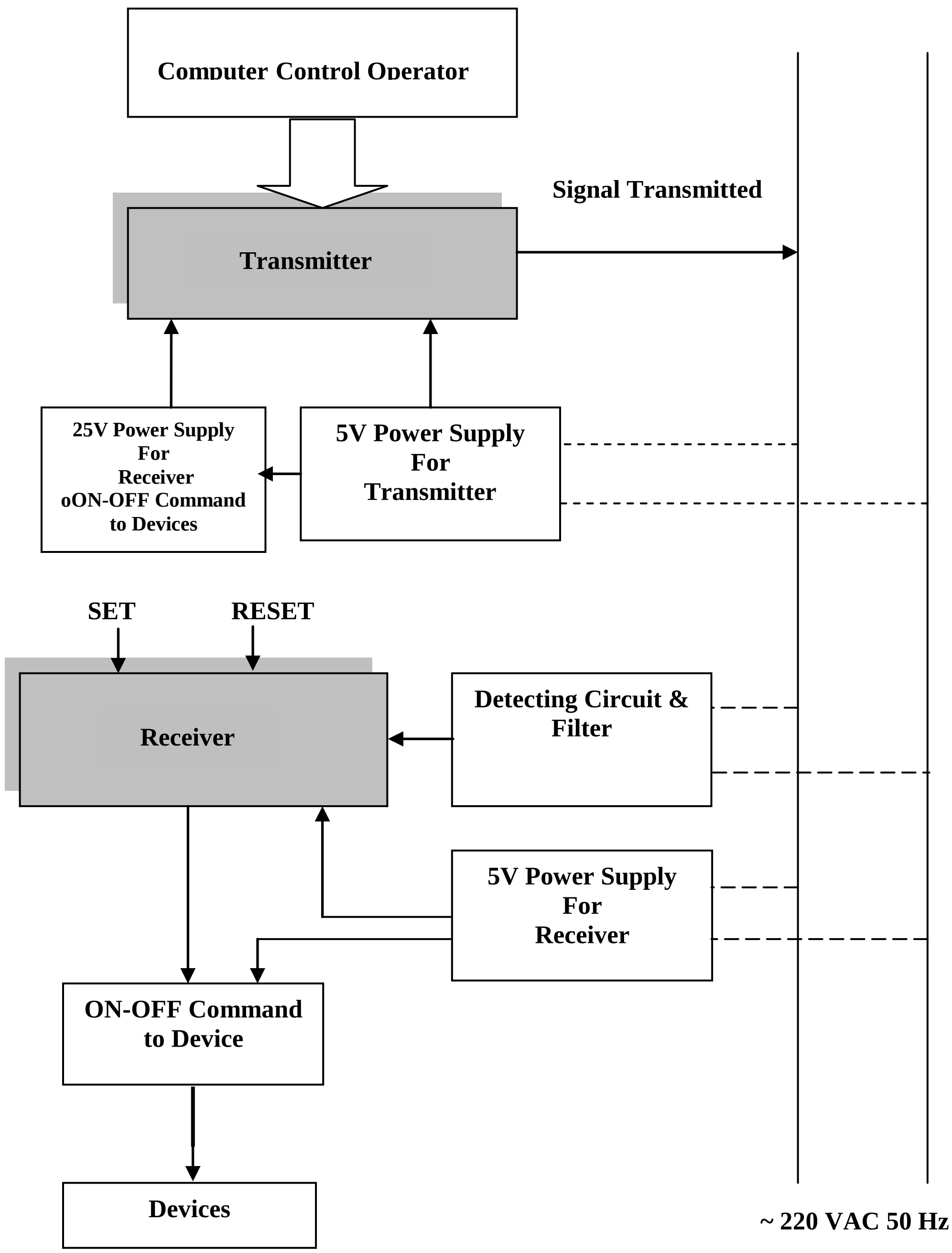


Figure (1): Block diagram of wireless AC remote control system.



Figure(2): Block Diagram for the System

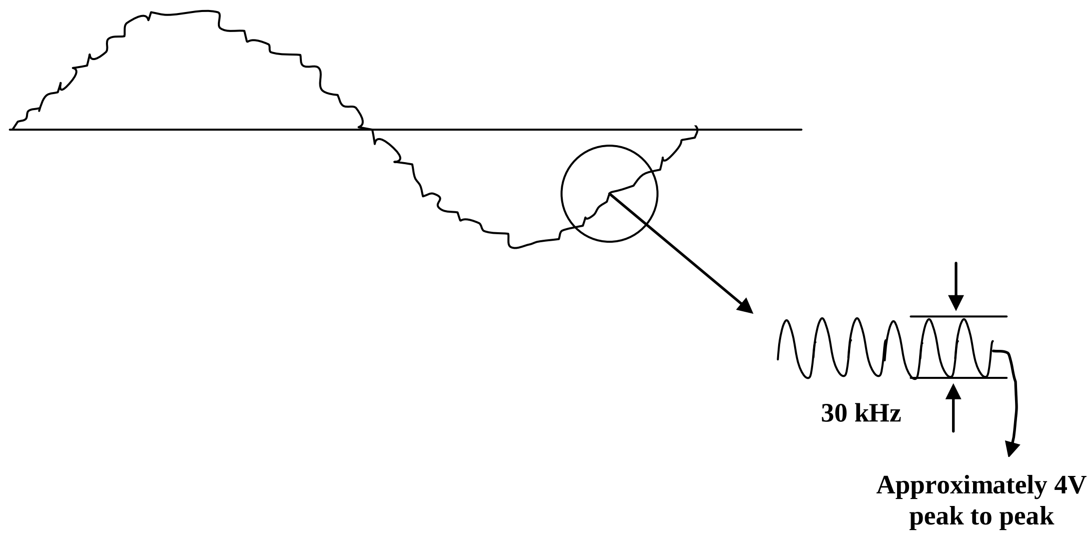
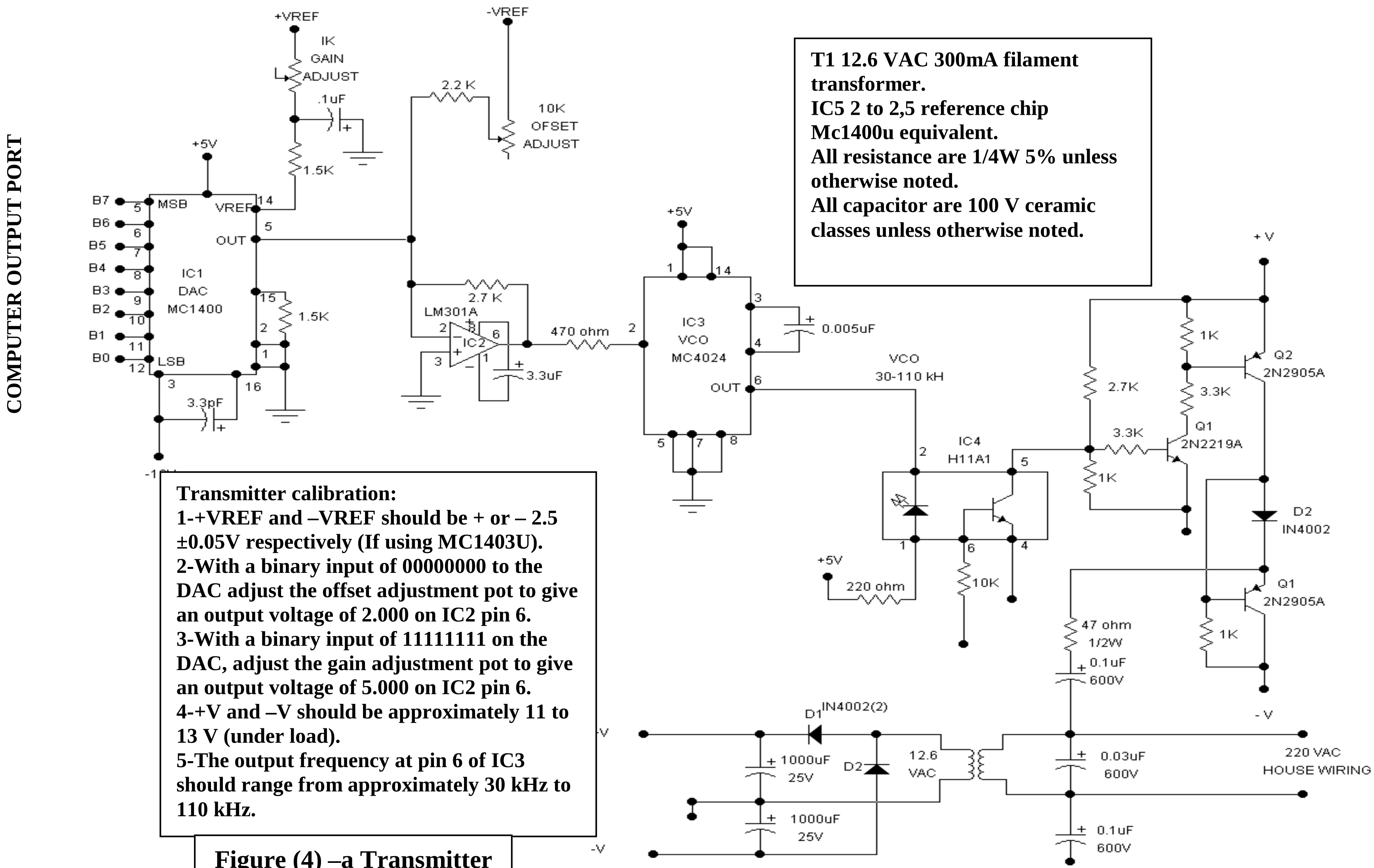


Figure (3): Example of current transmission

The standard 50Hz 220 VAC sine wave is shown being modulated by 3 0 kHz carrier. Two difference frequencies 4 kHz upper are used to turn devices ON or OFF respectively



T1 12.6 VAC 300mA filament transformer.
IC5 2 to 2,5 reference chip Mc1400u equivalent.
All resistance are 1/4W 5% unless otherwise noted.
All capacitor are 100 V ceramic classes unless otherwise noted.

Transmitter calibration:
1-+VREF and –VREF should be + or – 2.5 ±0.05V respectively (If using MC1403U).
2-With a binary input of 00000000 to the DAC adjust the offset adjustment pot to give an output voltage of 2.000 on IC2 pin 6.
3-With a binary input of 11111111 on the DAC, adjust the gain adjustment pot to give an output voltage of 5.000 on IC2 pin 6.
4-+V and –V should be approximately 11 to 13 V (under load).
5-The output frequency at pin 6 of IC3 should range from approximately 30 kHz to 110 kHz.

Figure (4) –a Transmitter

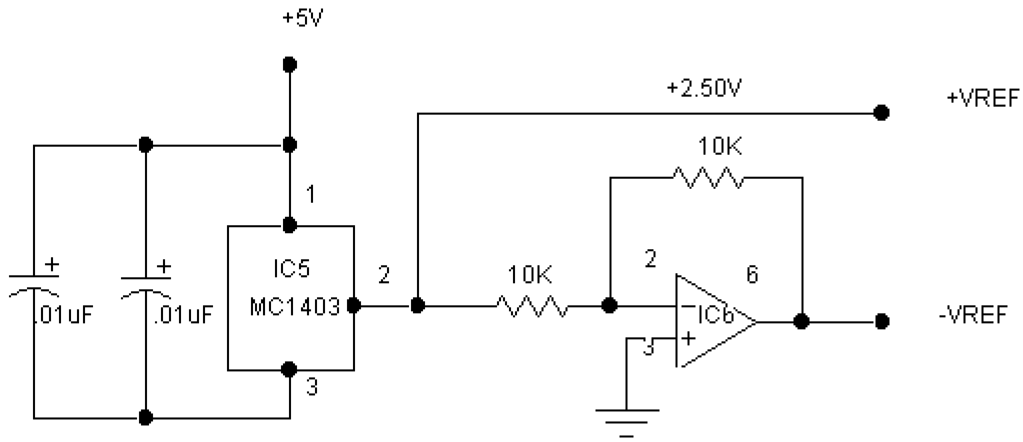
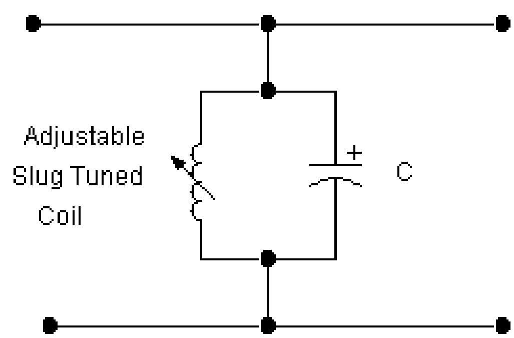
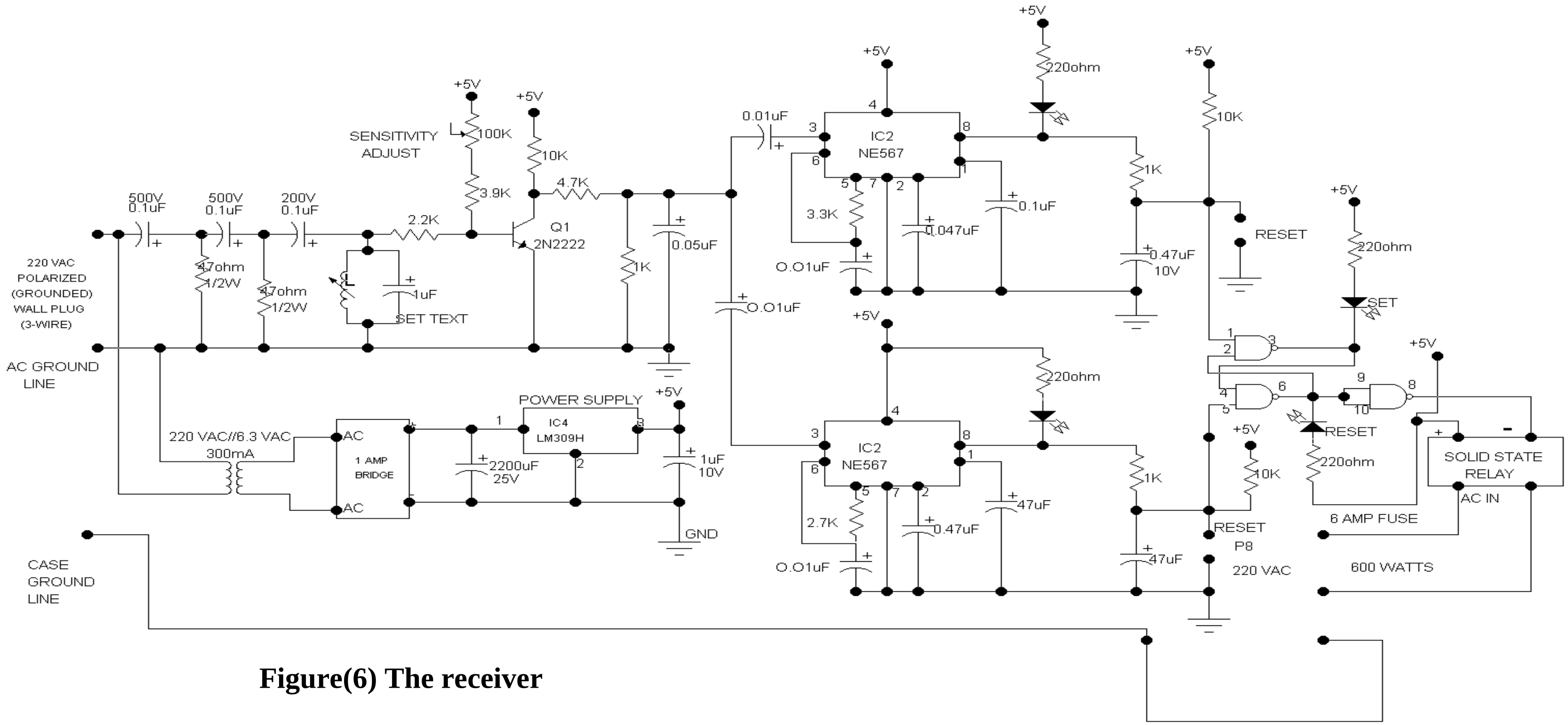


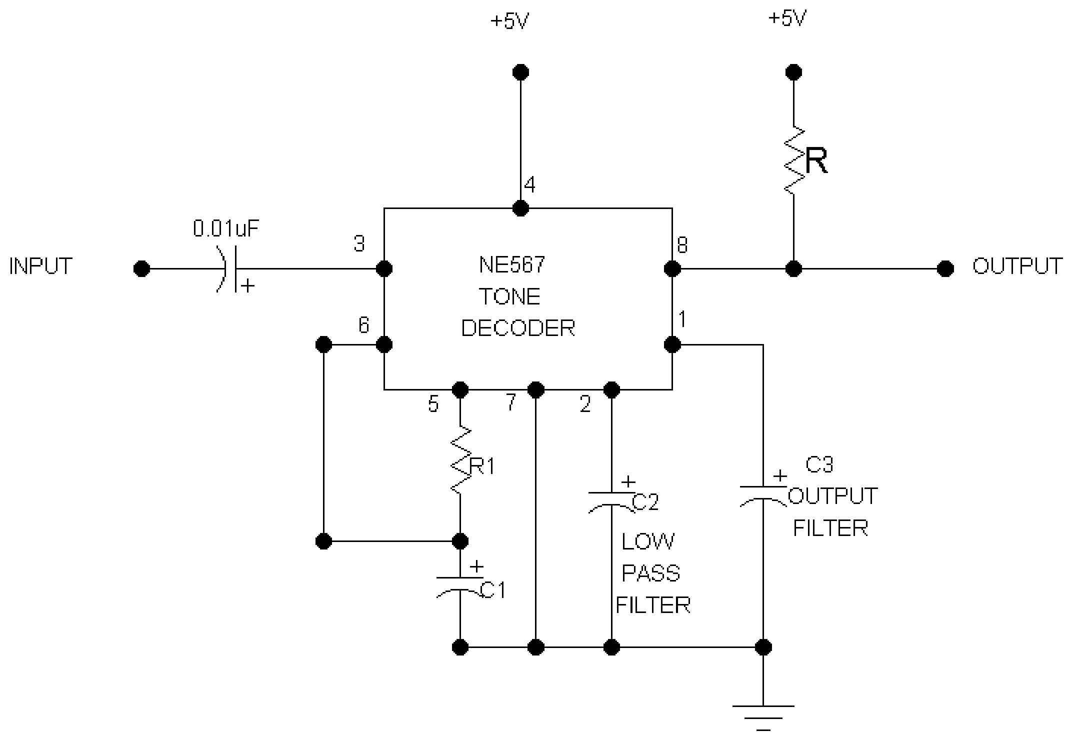
Figure (4-b) Production of 2.50 v source For use with the transmitter in fig 2-a



Figure(4-b) Production of 2.50 v source For use with the transmitter in fig 2-a



Figure(6) The receiver



Figure(7) Selection of components for the tone decoder

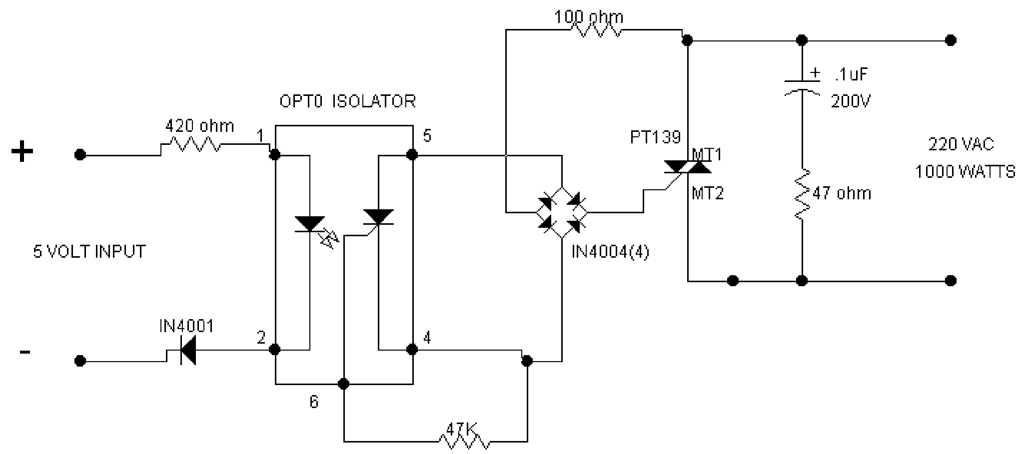


Figure-8: 10A Solid state relay suitable for use in a TTL to 220 VAC application

Table (1): Power Wiring Table for figure 4 a and b

Number type	+5v pin	-12v pin	GND pin	+12v pin
IC1 MC1408	13	3	2	-
IC2 LM301A	-	4	-	7
IC3 MC4024A	14	-	7	-
IC4 H11A	-	no Supply pins designated		
IC5 MC1403	1			
IC6 741	-	4	-	7

Table(2): Power Wiring Table for Figure - 6

IC NO.	IC type	+5V	GND
IC1	NE567	4	7
IC2	NE567	4	7
IC3	7437	14	7
IC4	LM309	3	2