CHAPTER 7
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Special Needs Communication Board

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INTRODUCTION

This Special Needs Communication Board is designed to aid those who have difficulty with oral communications. The SNCB is able to store and play back five messages, each with a length of approximately four seconds. The device is a portable rectangular box with five messages activated by push buttons, one play/record switch, one volume control switch, a speaker and a microphone. The SNCB is designed around a single ISDlOOOA chip and powered by alkaline batteries that are easy and inexpensive to replace. If special modifications are necessary, such as longer messages or bigger push buttons, it is easily adapted to fit those needs. It also is built solidly enough to take rough handling or different climatic changes, and still function properly.

SUMMARY OF IMPACT

The Special Needs Communications Board (SNCB) is designed to help speech-impaired members of the Open Door Group Home in Valley City, North Dakota communicate. Everyday needs or requests such as "Please repeat the question", are more easily conveyed. The user writes down five important messages, and the supervisor then records these into the SNCB. This allows the user to easily convey common phrases they use in everyday communication.

TECHNICAL DESCRIPTION

The operation of the SNCB is centered around the Voice Play/Record chip, specifically the ISDlOOOA CMOS integrated circuit (IC). The ISDlOOOA has an analog-sampled data system with an on-chip microphone pre-amplifier, anti-aliasing filter, automatic gain control, a smoothing filter, power amplifier, control logic and an analog storage array. This chip is chosen because everything is contained in a single IC, which reduces the number of components that would normally be needed. The ISDlOOOA has a non-volatile EEPROM memory storage cell that does not lose the recorded messages when power is disconnected during a battery change.

The power supply for the SNCB is four "D" alkaline batteries in series. Alkaline batteries are chosen because of their price and availability to the general public. When the voltage drops below 3.9 volts, the **low** power LED illuminates. When the battery output drops to 3.5 volts, the playback quality diminishes and an internal low voltage detector on the voice chip causes the device to remain in Play Mode regardless of the play/record pin status.

The ability to record over existing messages is easily accomplished, due to the features of the speech chip. The chip holds twenty seconds of memory divided into 1/8th of a second intervals. This makes up 160 pieces of memory. Once the chip is addressed, it starts recording (when it is in the record mode). The Play/Record rocker switch is developed from the schematic given in the ISDlOOOA manual. This allows any message to be recorded over.

A dynamic microphone is chosen to diminish any background noise while recording messages. No extra power supply is needed for this type of microphone. The pre-amplifier is already built into the chip, therefore only filtering capacitors are needed on the inputs. These capacitors eliminate the high end "pops" that may occur when recording.

The five separate messages are developed by connecting the message push buttons to the address pins on the ISDlOOOA through OR gates. This gives each message a separate address that is evenly spaced four seconds apart on the chip. These message push buttons are also connected to a monostable 555 timer that turns off both the play and record mode four seconds after the message is activated. This assures other messages will not be recorded over, and only one message is played at a time.

The push-buttons are made of a durable plastic with the surface area of approximately 0.5 square inches. Next to each button is an open area to label the button with the corresponding message. When a push-

button is pressed, the LED lights up. This helps the user by indicating a button was depressed, and stays on for the duration of the message.

The speech chip has an internal amplifier built in, but this was not enough to give us the desired volume on the output. We used an LM386 amplifier to increase the gain at the speaker output. The output of the amplifier is then connected to an SPDT rocker switch, with a resistor across the output terminals of the switch. This gives the user a "high" and "low" setting for the volume control. The output of the rocker switch is then connected directly to the eight-ohm speaker.

The Special Needs Communication Board is designed to meet the following criteria laid out by a supervisor at the Open Door Group Home.

- Portable
- Four to eight large, sensitive, and well spaced push-buttons
- Play a short voice message and emit a visual signal when the button is pressed
- Ability for supervisors and therapists to change and add messages

The cost of this project is approximately $100.

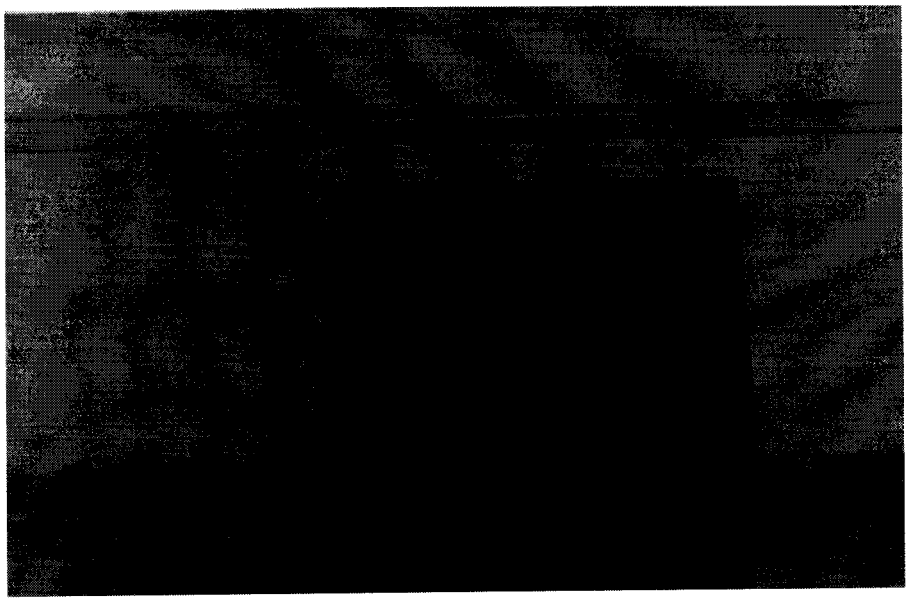

Figure 7.1. Special Needs Communication Board.

Remote Control Door Unlock

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INTRODUCTION

The remote control electric strike consists of a transmitter-receiver, control circuitry, and electric strike is designed for a handicapped individual with limited hand and arm dexterity. It unlatches the trigger of an outside door when the button on the transmitter is pushed. There are several advantages in this design. The transmitter is small and easily mountable on a wheelchair. Because it uses radio frequency, it can be operated from either side of the door. The receiver and control circuitry use a battery back up to operate normally when there is no power from the wall. A disadvantage is the design does not include mechanisms to also open the door.

SUMMARY OF IMPACT

The remote control door unlock was specifically designed for a handicapped girl in the Fargo, North Dakota area. She is currently very dependent on her parents for any movement inside and outside of her house due to her inability to turn a doorknob. She is capable of pushing buttons, such as a telephone button. This device is designed with that ability in mind. The remote control door-unlocking unit allows her more freedom of movement and provides self-reliance and self-confidence.

TECHNICAL DESCRIPTION

The function of the remote controlled electric strike is to unlatch the outside door when activated. The four distinct units of this system are the transmitter, receiver, control circuitry and electric strike. The transmitter has two buttons and is mountable on the client's wheelchair tray. The transmitter sends an encoded signal when the button is pushed. The antenna of the receiver picks up the signal and decodes it. The receiver is mounted in the wall near the door it opens. The receiver sends a signal to the control circuitry that sends a pulse to the electric strike. When initiated by this pulse, the electric strike allows the trigger (bolt) of the door to pass through the strike plate (catch). The pulse lasts for a pre-specified time, after which the strike plate returns to a locked state. The electric strike is completely contained in the doorframe.

The remote control door design operates off two power supplies, a standard US 120V 60Hz outlet and a 15V battery. An AC to DC converter is used to convert the AC voltage to 12VDC that is the main power supply. The 15V battery backup receives its power from ten 1.5V AA batteries connected in series. The circuit uses a single pole-double throw relay to switch between power supplies. The 15V battery is connected to the normally closed side of the relay, while the 12VDC from the wall is connected to the active closed side of the relay. Another feature present in the design is a low battery detection circuit. This circuit illuminates an LED when the battery backup drops below 10VDC.

The output of the relay is connected to two 6V-voltage regulators. The load (the door lock) can only handle voltages in the 3VDC to 6VDC range, which necessitates the use of a 6V regulator. Two regulators are connected in parallel to handle the large currents that the load draws, usually 0.8A to 1.3A range.

A prefabricated transmitter-receiver pair is chosen to provide proven reliable, small size and FCC compliance. The output from the transmitter is radio frequency electromagnetic waves. This enables the signal to pass through small obstructions. The transmitter is powered by two 3-volt Everyready type CR2016 batteries. The receiver draws its power from the control circuitry.

The control circuitry is triggered by the receiver. The receiver sends a low pulse to the 555 timer when it recognizes the coded signal from the transmitter. When activated, the 555 timer sends out a four volt eight second pulse through a diode to the gate of a power MOSFET (HEXFET). The diode is used to block any signals that may otherwise travel back into the 555 timer and interrupt proper execution of the eight second signal. The eight seconds is chosen to

comply with the limitations of the electric strike. Documentation for the strike indicates that the strike is to be continuously active no longer fifteen seconds.

The HEXFET acts as a switch that provides a path to ground for the electric strike (load). The outputs of the regulators are connected to one side of the load. The other side of the load is connected to the DRAIN of a HEXFET. The SOURCE of the HEXFET is grounded so that when the GATE receives a signal it switches ON, the load becomes grounded, and the lock opens. A free wheeling diode is also connected in shunt across the load to avoid sudden current changes to the load. Without the diode in shunt, the lock would "chatter" and eventually burn out.

The important components of the electric strike plate are the latch and the solenoid. The control circuitry controls the voltage applied across the terminals of the strike plate. When the required voltage is dropped across these terminals, current flows through a coil that surrounds the solenoid. A force induced by the current moves the solenoid. A rolling block is moved in and out of the way of the latch by the solenoid. The latch itself is curved approximately one quarter circle. It rotates freely when the block is out of the way. A spring returns the latch to its initial position. The electric strike plate is installed on the wall edge of the door opening. The door is still accessible by the standard lock and key. On complete power failure the latch fails secure (does not release). The original locking mechanism (such as a dead bolt lock) on the door remains unchanged during operation of the remote controlled electric strike. Only the latch is affected.

The approximate cost of this design is $130.

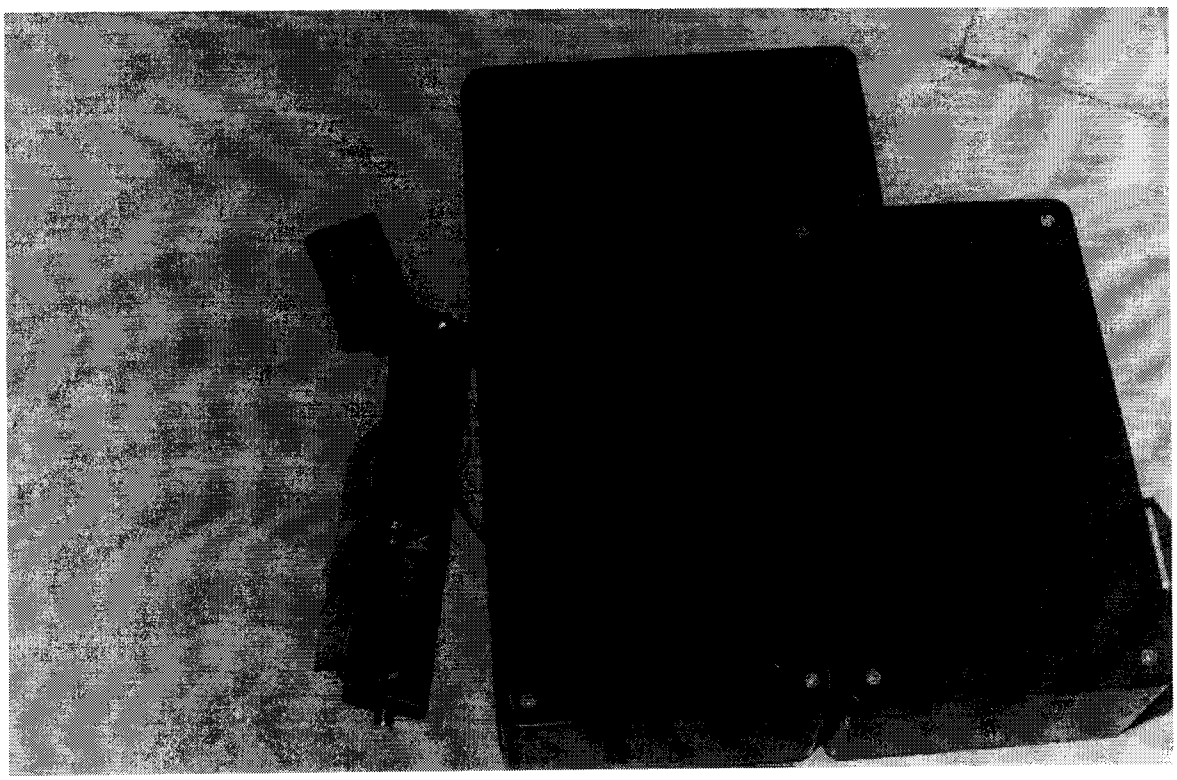

Figure 7.2. Remote Control Door Unlock Unit and Transmitter.

Remote Control Digital Thermostat

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INTRODUCTION

Thermostats are typically placed out of reach for individuals who may be in a wheelchair or bedridden, making simple tasks such as adjusting a thermostat quite difficult if not impossible. The remote control digital thermostat will allow a person to adjust the temperature from almost any location within a room. The remote control digital thermostat consists of two main units: a two button radio frequency (RF) remote control unit and the wall mounted base unit. The desired temperature is changed by one degree Fahrenheit with a push of the button on the remote control. An indicating light on the base unit informs the user that a signal has been received. The base unit also has an LED display of both the actual and the desired room temperature. Control logic within the base unit compares the actual room temperature and desired room temperature, and sends a signal to change the temperature. The base unit is placed on the wall with the existing thermostat to allow use of the existing unit should this system fail.

SUMMARY OF IMPACT

Everyday tasks can create substantial obstacles for physically challenged individuals. Any device, such as a remote control thermostat, will help a physically challenged person have a more independent living environment. The remote control thermostat allows a person to easily control the room temperature from anywhere within the room. One feature of the device is the user does not have to point the remote directly at the base unit to change the room temperature. A disadvantage is it may be difficult for those who lack proper motor skills to depress the remote control buttons. However, the buttons could easily be redesigned to fit another users' needs.

TECHNICAL DESCRIPTION

The Remote Control Digital Thermostat consists of six main parts:

- Temperature Sensor and Conversion
- RF Transmitter and Receiver
- Temperature Control Logic
- LED Displays and Supporting Circuitry
- Relay System
- Power Supply

The actual temperature is measured by a National Semiconductor LM 34 temperature sensor. The sensor outputs 10mV for each degree Fahrenheit. An analog to digital converter converts the temperature sensor's output voltage to an 8-bit binary number that is sent to a group of four 4-bit BCD (binary coded decimal) adders. These BCD adders convert the number to two 4-bit BCD digits representing the room temperatures "ones" digit and a "tens" digit. These two digits are sent to the actual temperature LED display system and to the Temperature Control Logic (TCL). A 555 timer and two cascaded binary counters are configured so the A/D converter will read the temperature every minute.

The desired temperature is set by the remote control unit that consists of the LM1871 RF encoder/transmitter chip with supporting circuitry and two push buttons for temperature control, one to increase and one to decrease the temperature. When a button is pushed, the transmitter chip transmits one of two channels. When a signal is received, an LED on the front of the base unit will illuminate, indicating to the user that a signal was received. The receiving unit consists of the LM1872 RF decoder/receiver chip with supporting circuitry. The two channels received from the transmitter are fed into the TCL (Temperature Control Logic). In the event that the remote is lost or inoperable, there are two momentary switches on the base unit that can be used to control the thermostat. Each switch is connected to a SR latch, which sends a signal to the Temperature Control Logic Circuit to increase or decrease the temperature.

The Temperature Control logic consists of two 74LS192 up/down counters, two 74LS85 comparators, and four 7400 NAND gates (see Figure 7.3.) One up/down counter representing the "ones" digit receives a signal from the receiver section to increase or decrease the desired temperature. If a nine goes to a zero, or zero goes to nine in the "ones" counter, it sends a signal to the "tens" counter to increases or decreases its count. The "ones" digit and "tens" digit counters send a BCD digit to their respective comparators and the desired temperature LED display system. The "ones" digit comparator compares the "ones" BCD digits from the desired temperature and actual temperature. The "ones" comparator sends three signals to the "tens" comparator. These signals are A<B, A=B, or A>B, where A is the actual temperature and B is the desired temperature. The "tens" comparator compares the "tens" BCD digits from the desired temperature counter and actual temperature along with the three signals from the "ones" comparator. The "tens" comparator sends three signals A<B, A=B, and A>B to a logical configuration of four NAND gates. If the actual temperature is less than the desired temperature, the output of the NAND gate sends high to the relay system. If the actual temperature is greater than the desired temperature, the output of the NAND gate sends a low to the relay system.

The output relay, which is a single-pole-double-throw (SPDT), is connected in parallel with the existing thermostat in the event that the Remote Control Digital Thermostat should fail. One double-pole-double-throw (DPDT) switch is placed in series with the relay to prohibit the simultaneous use of the cooling unit and heating unit. The user sets the switch to the "cool" position in the summer months and the "heat" position in the winter months.

The actual and desired temperatures are each displayed on two seven-segment LED displays. Each LED display is illuminated by a seven segment decoder/driver, 74LS47. The decoders for the desired temperature section each receive a 4-bit BCD word from the TCL. The decoders for the actual temperature section each receive a 4-bit BCD word from A/D conversion of the temperature sensor.

The voltage available from the existing thermostat circuitry is 24VAC at 60Hz. The RF system requires 5VDC. To transform the input power into the required values, a bridge rectifier and a voltage regulator of 5 volts are used in conjunction with a capacitive filter. The power supply is capable of supplying 1.5 amps that is more than the system load of 1.2 amps. The cost of the device is about $215.

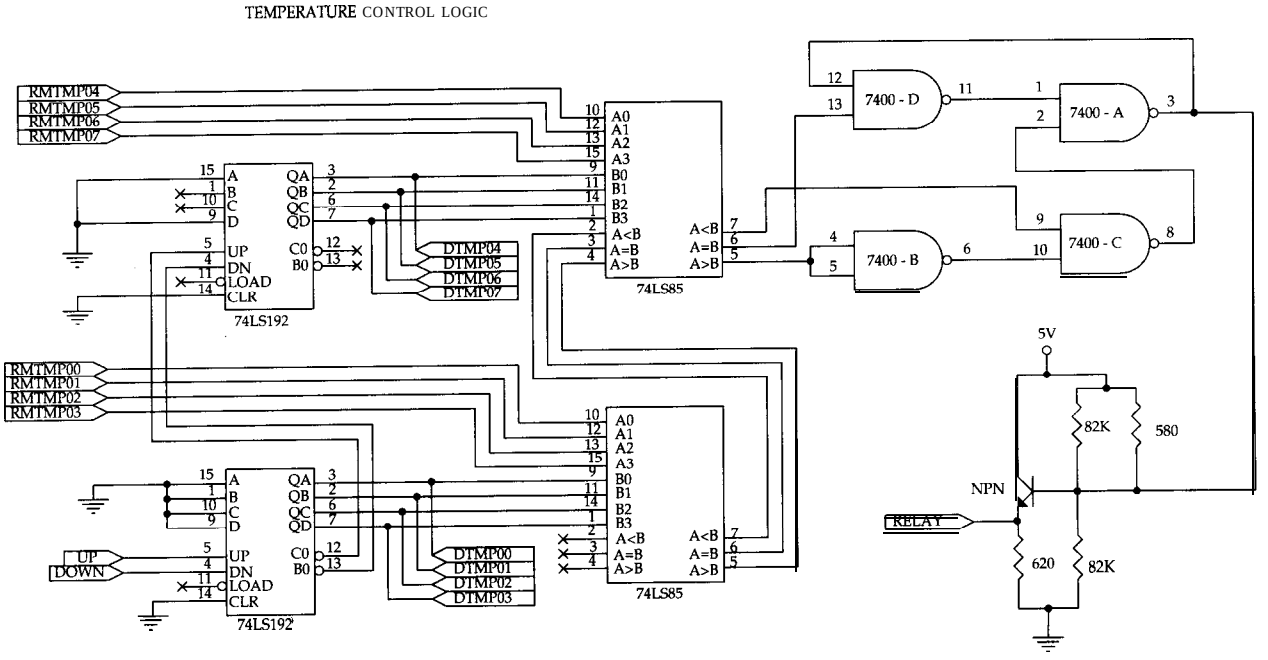

Figure 7.3. Temperature Control Logic.

Remote Handicapped Door Opener

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INTRODUCTION

Current handicapped access doors provide a valuable service to handicapped individuals; but they can also present new difficulties to the handicapped person. The' Remote Handicapped Door Opener (RHDO) is designed to improve the already existing handicapped door openers. The RHDO is an infrared transmitter mounted on a wheelchair and receiver incorporated into the existing handicapped access doors circuitry. A handicapped person is able to open a door from their wheelchair with the push of a button.

SUMMARY OF IMPACT

The simple task of opening a door may not be so simple for a handicapped person even with button activated automatic door openers. A handicapped person may have difficulty depressing the switch. After the switch is pressed, the person may have to maneuver around or away from the swinging door. During this time, the moving door could cause slight injury to the person or damage to their wheelchair. Poor weather conditions may further aggravate the problem. The Remote Handicapped Door Opener is designed to help alleviate some problems that handicapped people may encounter with automatic door openers.

TECHNICAL DESCRIPTION

The Remote Handicapped Door Opener contains two major parts: a transmitter and a receiver. The transmitter sends out a signal that is detected by the receiver. The receiver is connected to a switching circuit that activates the opener when the signal from the transmitter is received.

The transmitter can be broken up into three separate parts: low power indicator, user-activated switches, and outputs. The low power indicator circuit consists of a 6.2V Zener diode, two NPN transistors, and red LED. When the 9V-power supply goes below 6.2V, the Zener diode allows sufficient biasing to turn the two transistors and the red LED. The user-activated switches are located directly under the four comers of a large button on top of the transmitter casing. These four switches are connected in parallel. If any one of these switches is activated, power is supplied to the output portion of the transmitter. The output portion of the transmitter consists of a 555 timer, a green LED, an infrared emitting diode, four resistors, and a capacitor. When one of the switches are activated, the 555 timer sends out voltage pulses that supplies current to the infrared emitter and the green LED. The pulses will have 50% duty cycle with a target frequency of 40 kHz. The green LED indicates that transmitter is sending out a signal.

The receiver is partitioned into four separate parts: power supply; IR Receiver module; comparator; activation switch. The power supply consists of two nine-volt batteries and a low power indicator of the same type used in the transmitter. The IR receiver module consists of a 3-pin module. Pin 3 of the module is connected to ground. Power is supplied to pin 2 of the module through a 220 Ω resistor. Pin 1 of the module goes through a 1M Ω resistor, which is connected, to ground. With no input, the voltage across the 1M Ω resistor is initially high (≈ 8V). Once the IR Receiver module senses the transmitter signal, this voltage falls low (≈ 4V).

The comparator consists of the voltage input from the IR receiver module, a reference voltage (≈ 5V), and supply voltages of ± 9V. Once the input voltage falls below the reference voltage, the comparator output voltage goes high to equal V+ (≈ 9V). When the input voltage is greater than the reference voltage, the comparator output voltage goes low to equal V- (≈ 9V).

The activation switch consists of a relay in parallel with the circuitry for the existing handicapped door opener. The relay is a normally open relay, when energized, the relay changes states and closes. When the transmission signal is detected, the relay's voltage

input goes high (≈ 9V), and the relay closes. This relay action closes the switch in the existing opener circuitry and causes the door to open. When the relay's voltage input goes back to low, the relay opens.

The final design is functional, but it does contain some small dysfunction that could jeopardize its practicality. The receiver relay resonates (chatters) when the signal is being received. This problem could be due to hysteresis within the voltage comparator. However, we proceeded with the design under the assumption that if the relay closed at any moment (resonating or not), the door activation device would be triggered. It would have been beneficial to test our assumption on a current door-opening device, but we are not able to get authorization to do this.

The total cost is estimated to be $40.

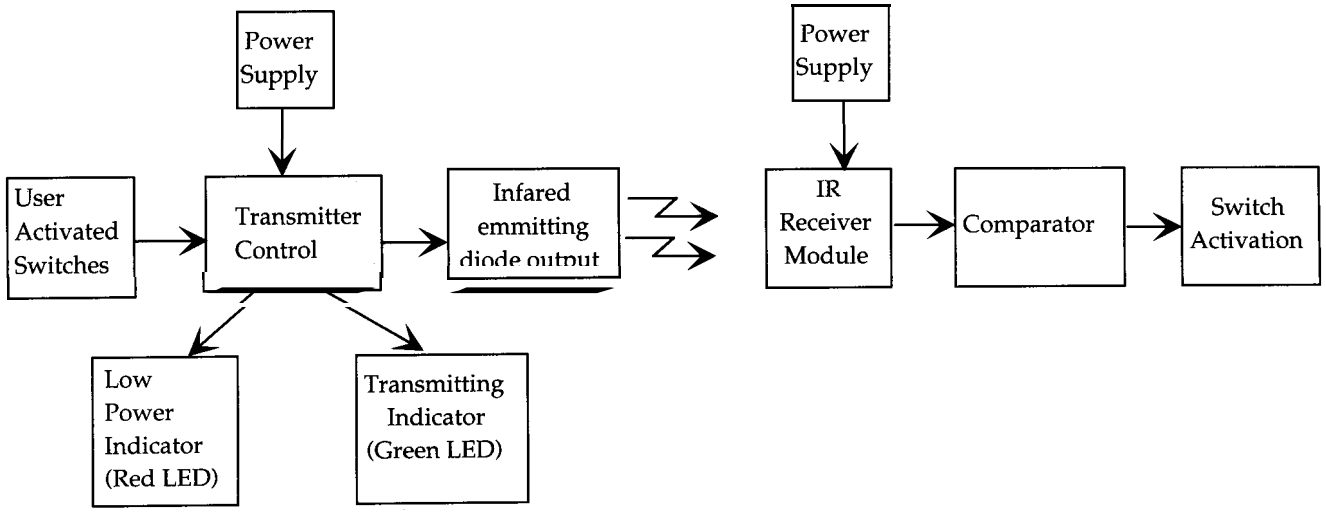

Figure 7.4. Diagram of Transmitter and Receiver