To Develop a New Electric Aluminium Blinds Based on Infrared Remote Control Technology

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Abstract: - The conventional aluminium blinds have many outstanding functions, for example, closed off over daylight, sun shading, environment decorating, less dissipated energy consumption in air-conditioner and lighting system. However some critical problems have not solved yet. First, the inclined angle of blinds is over relied upon user. The operation efficiency is too low to use. Second, some media reported that the operation rope of aluminium blinds used for adjusting the inclining angle of blinds wind around child and even lose their live finally. Third, the total indoor room decoration would be destroyed in order to install aluminium blinds body. Fourth, the operation of traditional aluminium blinds can only be controlled by people directly by using their hands. Because of designed unfriendly, it is inconvenient and not comfortable. Therefore, this paper presents a new compound electric aluminium blind which is composed of most mechanical mechanism of the traditional aluminium and limited manufacturing cost. Alternating current (AC) power line, battery or adapter (DC), or even solar cell can be selected as the power source of the proposed electric aluminium blinds. No operation rope is needed again. The amount of wind around events for home children should then be decreased or disappeared completely. Since the infrared remote controlling equipment is introduced in new aluminium blinds system, users need not operate and touch the compound electric aluminium blinds directly and the operating range of equipment is also increased too. Especially, the total indoor room decoration will not be affected or destructed due to the affiliation of aluminium blinds. When the intensity of outdoor daylight is strong enough, the PV is naturally chosen as the power of compound electric aluminium blinds. This is a practical step to pursue the object of green buildings. The economic value of these compound electric aluminium blinds would be as well as promoted.

Key-Words: - Conventional aluminum blinds, Compound electric aluminum blinds, DC motor, Solar cell, Alternating current, Battery.

1 Introduction

In the past, the increasing buildings and house rooms are widely built in the whole world. Moreover, there is more and more electrical energy is dissipated in lighting purposes. If the power saving purpose only depends on the building owners or lighting users, this purpose must not be easily come true. In order to improve the lighting efficiency, more and more technicians use modern technology and sensors in the lighting area. If someone enters the monitored lighting area, a signal will be sensed by a suitable sensor and immediately transmitted this signal to the system controller. The system controller will command the lighting equipment is illuminated. In case of the people leaves the monitored area; the lightings will be distinguished right now. The disadvantages of this lighting control method is that the lighting intensity of monitored area which maybe come from other lighting. At the same time, a movable sensor for sensing the lighting intensity is required. A lot of movable lighting sensors are necessary; therefore, the installation cost would be increased too.

The other power-saving method in the general buildings is to change or modify that the lighting intensity by fine tuning strategy. By means of the operation of user or owner, the lighting intensity of inside building is suitably controlled. Although the lighting intensity is adjusted by people, much more electrical power energy is then saved. If indoor space should have a constant lighting intensity, it is difficult and impossible for people to control the lighting intensity at any time. In the recent decades, there are some experts paid more their attention on the control method research related to the lighting intensity. By using the sun shine to provide part of the lighting intensity inside building, a few researchers have successfully achieved the electrical

energy-saving result which original dissipation in indoor illumination. For example, the energy committee of California state government was aimed at researching the method how to save the electrical energy dissipated in public illumination. This project was only to consider the lighting turn on/off control of indoor illumination. The effect of the outside lighting intensity on the indoor lighting intensity was never considered [1,5].

For achieving the power efficiency of indoor illumination, it is very inexpensive for the user to control the indoor light intensity by turning on/off method. The other one may also be more effective and reasonable a bit by using fine tuning method. According to many experimental results, if part of the indoor light intensity is supplied with outdoor sunshine, generally about 20~60 percentage of the total electrical power dissipated in indoor light illumination may be reduced. The actual electrical energy-saving percentage is entirely decided to the controlled area neighbouring environmental sun intensity [2-4,6]. If the outdoor sunshine intensity is sufficient, it should be rewarded for the building owner to adopt outdoor sunshine intensity to supplying with the indoor illumination. If a building reserves a lot of skylights or windows, there is a lot of chances to save more electrical energy dissipated in indoor light illumination. Many indoor spaces like offices, public buildings and schools, maybe more outdoor sunshine can be used and projected into indoor space and served as indoor illumination. It is a reasonable result for the more window installed, the more electrical energy saved. Some equipment such as the aluminium blinds have to be prepared for blocking the excessive sunshine intensity some time. To achieve higher electrical power energy-saving purpose from indoor illumination, the illumination designer should first realize that different lamps often have different characteristics as well. In general, a natural light such as sunshine can be obtained from outdoor, it is cheap. On the contrarily, an artificial light is often generated by a light bulb and it should be supplied with electrical power. The other important factors concerning to the indoor illumination, such as the installation position and inclination angle of light, the installation position of light sensor and so on. Furthermore, the colour of indoor illumination is also affects the read value [7].

Up to now, a lot of different control methods were proposed to control the angle of inclination of aluminium blinds. Chen et al. [4] designed a control method which included a fuzzy controller and two feedback loops for controlling the inclination angle of aluminium blinds. In most applications, the critical and concerned things by users almost is the amount of sunshine thrown into inside building, therefore, it is not a important problem whether the inclination angle of natural light can be precisely controlled by the controller or not. The proposed control method by Chen's therefore can be further simplified to a control structure only with a feedback loop. In reference [5], Viereck has ever made use of some MEMS devices to complete the inclination angle control of light. In another control method, the wireless communication approach was also used to transmit the sensed environmental light data between all the installed light sensors. The control structure of this method basically has two advantages such as easy installation and free of any connection cable. But the manufacturing cost is expensive and it is easily interfered by other environmental noise sources. According to the basic configuration and using experiences over past years, some disadvantages related to the traditional aluminium blinds can be concluded and given as followings [8]:

(a) Larger size: To obtain more natural sunshine thrown into inside building, lots of buildings has a common feature is that installed number of window generally as many as possible. As the season change, the inclination angle of sun is different as well. Sometimes, more sunshine is thrown into inside building through window and made people uncomfortable. The people works or lives in building. Sometimes, he or she needs a personal space for special purpose. The aluminium blinds may be the best choice product. In case of the size of aluminium blind is too large to easily control, it is inconvenient. The operation of traditional aluminium blinds is controlled by people is not economic too. As the number of window is increasing, the control of traditional aluminium blinds would waste much time and people.

(b) Hidden danger: The traditional aluminium blinds are controlled by people directly. For example, the adjustment like scroll up or scroll down and the inclination angle of the Aluminium blinds. All the adjusting operations of the aluminium blinds are completed through a rope with pebble material. To take the manufacturing cost into consideration, the operating mechanism of this traditional aluminium blind is designed as simple as possible. In recent years, some accidental events occurred and even people died due to the conventional aluminium blinds. Most of accidental cases were made by babies. However, the using or buying willing of the traditional aluminium blinds has greatly decreased in recent year.

(c) Insufficient appearance: In general, the value of the building is not only affected by the environmental living functions, but also does the indoor building whether is decorated well or not. In order to promote the value of building, extra decorations will be added into the indoor building. The type and material of curtain plays an important role under the building decoration process. In addition, the installation of the window curtain should not require destroying original building frame.

(d) Inconvenient operation: The choice of the window curtain should first consider whether it is suitable for the basic necessities of building owners. Furthermore, the operation convenience is another critical consideration as well. In modern society, time is money, the operation of curtain depends upon people should be kept off now.

(e) Insufficient robustness: For some special purposes, the room arrangement is generally allowed to be adjusted at any time. This event often happens indoor of building. A movable window curtain is a better choice. Therefore, the flexibility of curtain design is important. Curtains only have fix appearance and frame becomes a worse design.

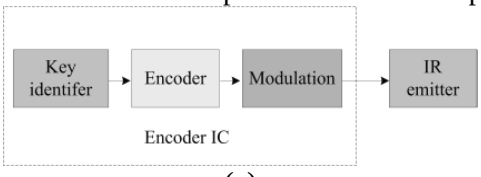
(f) Automatic temperature adjustment: One of important curtain functions is used to block sunshine directly projected into indoor building. If the projecting time is too long and the sunshine is strong, the temperature inside building would be increased very soon. For decreasing the temperature as soon as possible, much more electrical power would be then dissipated in the air conditioner of indoor building.

For the sake of using the outside nature sunshine, this paper presents an electronic controller which uses a low-cost hardware circuit and software to control the actions of window curtain. Due to part of the indoor illumination is partly provided by using outdoor sunshine. However the scroll-up, scroll-down and the inclination angle of curtain is driven by a DC brush motor with reduced gear box. The system is controlled by an electronic control unit (ECU). The control command is transmitted by means of a remote wireless communication through infrared medium. The amount of projected outdoor sunshine is controlled by using electronic control unit. In addition, the required electrical energy of the controller circuit can be selectively applied by dc adaptor or battery or solar-cell group. The proposed electronic controlled window curtain is then also called as compound electronic driven aluminium blinds.

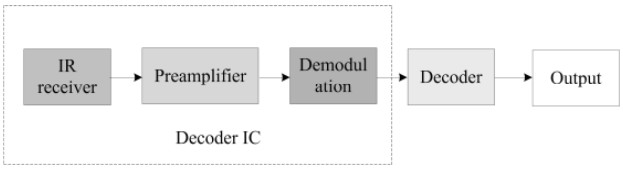
2 The Structure of Electric Aluminum Blinds

In order to achieve the operation of the electric venetian blinds through wireless remote control, the system controller commands is transmitted from a remote terminal via wireless infrared medium to receiver terminal. Since the manufacturing cost of infrared wireless remote control structure is inexpensive and reliable when it is used in indoor building application [11,12]. Consequently, many consumer electronic equipments have been controlled by employing this control method. In many applications, the manufacturing cost and remote control distance are two important considered control factors. From past many used experiences in practical applications, the electric aluminium blinds is being remote wireless controlled method by means of infrared medium. Fig. 1 shows a typical functional block structure of a popular infrared practical application. Fig. 1(a) is the functional block in transmission terminal. When the operator hope to control equipment through pressing an operating key, this control command signal will be first occurred and combined with address data of receiver terminal together and then encoded into a series of data. This action can only be completed by using an encode IC. By using infrared served as a transmitting medium, transmitted command is transferred from local terminal to the remote receiver terminal according to the address data. It should be worthy of notice that the infrared light is invisible and easy interfered by other signals, especially the outdoor sunshine.

In order to improve the transmitting yield percentage of wireless communication, there is a circuit is added to the latter circuit of decoder IC for strengthening the output signal. Fig. 1(b) diagrams the functional block related to the receiving circuit of infrared signal based on an infrared receiving module. When a signal is received by infrared receiving module, it will be decoded two parts, such as command and address data. In case of the address data of received data is identical to the remote address setting data of decoder IC, the received data will be output from the output pins of decoder IC. Certainly, the output data of decoder IC is the same as the transmitted command (or key data) in theory. Otherwise, transmission failure occurs and no signals or commands output from decoder IC pins.



(a)



(b)

Fig. 1 Basic functional configuration in (a) transmitter terminal (b) receiver terminal.

The mechanism of the proposed new type electronic aluminium blinds in this paper is also traditional aluminium blinds. In fact, only the necessary driven force for operating the aluminium blinds is changed from by people to by a DC motor. In the following, we will introduce the designing ideas and the working principle of detailed interface circuits in the transmitter and receiver terminals, respectively.

2.1 Remote Control Terminal

Based on infrared transmitting medium, the control command of electronic aluminium blinds will be generated from the transmit terminal. When this command is transmitted by infrared medium and received by infrared receiver module finally, the received data or command is decoded and outputted relative control command. The decoder IC will immediately inform the single chip to read the data appeared on the output pins of decoder IC [7]. By using suitable calculation and identification process, the real control actions will be carried out by the related mechanical and electrical mechanism in the receiver terminal.

The remote control of proposed new type of aluminium blind is generated by the operator. The commands are transferred from the transmitter terminal to the receiver terminal by means of wireless communication [10-15]. When a control command is received and decoded by the system controller in receiver terminal, a responding action will be switched on by the system controller. As shown in Fig. 2, the default number of commands in the transmitter terminal is four keys. That is scroll up, scroll down, auto light tracking, and stop. When one of four keys is pressed, the decoder IC included in Fig. 2 will decode the pressed key command into a series of binary data. This binary data consists of address, and meaning. To reduce the interference of transmitted infrared signal in the transferred process as possible as, the transmitted data will be first amplified and then transmitted by employing an infrared emitting diode with high frequency on/off square wave.

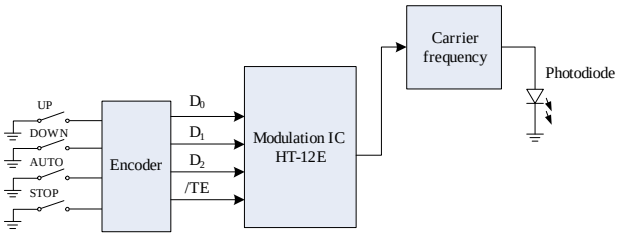


Fig. 2 Implementation idea related to the transmitter circuit through infrared media.

2.2 Receiver and Interface Circuits

Fig. 3 is the functional block diagram of the receiver terminal of the proposed infrared remote controller. As shown in Fig. 3, the designing ideas and the operating principles of the sub-system or interface circuits will be introduced in the following:

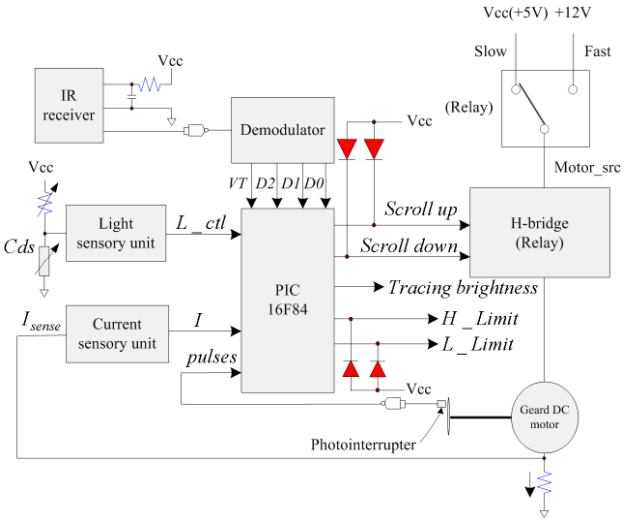


Fig. 3 Functional blocks of infrared receiver terminal and interface circuit .

2.1.1 Single chip

The infrared receiver of the system controller is developed based upon a single chip, which is produced by Microchip Company and serial number is PIC16F84A. The important electrical parameters are listed below [11]:

(1) 1K bytes EEPROM;

(2) 36 bytes SRAM and 15 special function registers;

(3) 64 bytes EEPROM，4 interrupt sources;

(4) 35 instructions, max. working frequency is 10 MHz。

(5) 13 I/O pins, includes input and output function, and they can be individually programmed;

(6) Every I/O pin has high driving capacity. It can drive LED directly. The maximum value of output current for each I/O pin is 20 *mA* and the maximum sink current is 25 *mA*.

(7) Includes an 8 bits timer or counter, there is a pre-scalar installed before the signal input of timer or counter and its counting range is 8 bits.

(8) There is a sleeping mode function. When the receiver terminal is needed to be situated in standby state, the single chip can enter into the sleeping mode for energy-saving purpose. If the power source is supplied with battery, the using time can then be prolonged since a little electrical energy is required by the electric circuits.

2.1.2 Circuits for sensing motor current and tracking the intensity of sunshine

In order to sense the dynamical moving position of aluminium blinds, there are two limit switches will be installed at top and bottom positions of the aluminium blinds. The proposed new electrical type of aluminium blinds is required to have a better appearance. Any of the mechanical switch like limit switch is not allowed to installed outside of the mechanism of the electric aluminium blinds. The dynamic moving position will be known by counting series of pulses generated from the output of an encoder-like mechanism. The encoder-like mechanism is composed of a reflected type of light interrupter. When the driven motor of electric aluminium blinds starts working, the light interrupter is rotated at the same time and a series of square pulses are outputted. These pulses are dynamically received and then counted by the single chip. The dynamical moving position of the aluminium blinds is then being updated immediately. In addition, a resistor with very low resistance is used as a current sensor and connected with the driven dc motor in series [8]. The dynamical current value of the dc motor will be first amplified and transmitted to the system controller. When the aluminium blinds has touched the top terminal of the mechanism, an abnormal larger current of the dc motor is generated and transmitted to the system controller. For the sake of safety, the dc motor will be commanded to stop running immediately.

The stable rated current value of DC motor is about 0.3 A, but the current value may suddenly be increased over 0.7 A when the electric aluminium blinds touches the top mechanical terminal. In order to test the happening time for this heavy load, a current comparator is designed and embedded in the system controller. If there is a signal is generated in the output of the current comparator, this represents that the mechanism of electric aluminium blinds has touched the top mechanical terminal. This signal is often used to turn the power source of DC motor off immediately in order to protect the mechanism and electric circuit devices from being destroyed. In addition, this signal is also employed to reset the position counter which is implemented by the software of the single chip to an initial value.

On the contrarily, when the mechanism of the electric aluminium blinds is controlled scroll down, a little current value generated because the load effect of DC motor is very light. The measured current value is about 0.15 A in this situation. If the overflow status occurred to the position counter, this represents the mechanism of electric aluminium blinds has touched its bottom end terminal. The mechanism will become scroll up if no stop signal is produced to turn the power of DC motor off. Of course, the motor current is increased right now.

Fig. 5 shows that the normal stable current values of DC motor during different working processes.

(1) Scroll down: there is a minimum load occurred to the DC motor, the stable current of DC motor is normally lower than 0.3 A;

(2) Scroll up: the required current of DC motor is increased from 0.3 A to 0.7 A;

(3) Upper limit: the mechanism of electric aluminium blinds has touched the top end terminal and even no movement again. Normally, the current value in this stage is larger than the other two stages and over 0.7 A.

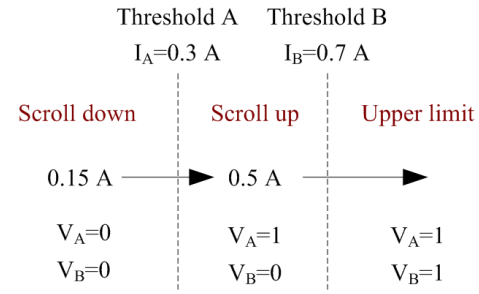


Fig. 5 It is shown that the required current of DC motor when it is run in different working processes.

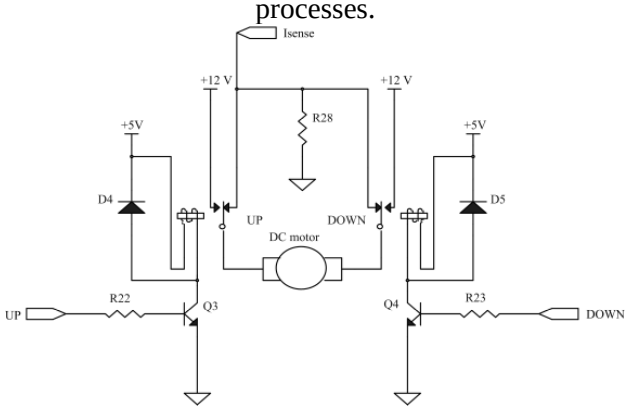


Fig. 6 The circuit for controlling rotating direction of DC motor.

The DC motor is reversible. In other words, it can be rotation in clockwise or counter-clockwise direction. Fig. 6 shows that the circuit for controlling the rotation direction of DC motor. The current sensor which is really a resistor associated with a very low fix resistance, 20 $m\Omega$, is connected with the DC motor in series. The benefits of the current measuring method are cheap, small, and reliable. The physical current value of DC motor is sensed by reading the amplified voltage drop across current sensor resistor.

2.1.3 Dynamic position sensory circuit:

As mentioned above, in order to measure the dynamic position of electric aluminium blinds, there is encoder-like sensor is equipped with the rotor axis of the DC motor. There are eight small circles distribution on its edge for measuring the rotation angle of DC motor. Therefore, the measuring resolution is 45 degrees. Fig. 7 indicates that the installed position of encoder-like sensory device.

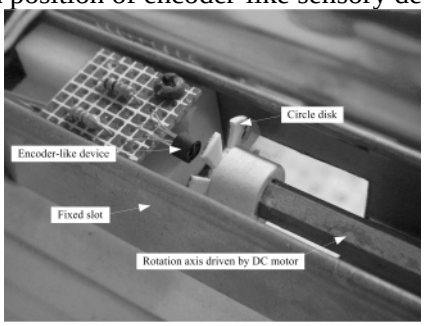


Fig. 7 Demonstrates that the equipped position of encoder-like device.

2.1.4 The speed control circuit

In order to control the inclined angle of aluminium blinds by using fine adjusting function, two voltage values are set for supplying with DC motor alternately. At the beginning stage, the DC motor is supplied with a typical voltage source, +5 V. After 5 seconds, a +12 V voltage source is in turn applied to the DC motor. The running speed of latter case is more than that in +5 V. The voltage supplying circuit is shown in Fig. 8.

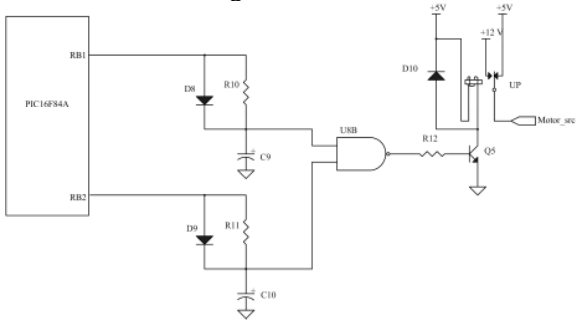


Fig. 8 The speed control circuit of electric aluminium blinds.

2.1.5 Light tracking circuit

Because the material of electric aluminium blinds possesses more or little expanded characteristic, the required small inclined angle of the electric aluminium blinds is always a very difficult work for most people. In this paper, two light intensity sensor, Cds, are installed indoor and outdoor building, respectively. These two light sensors are combined with the other two resistors with fix resistance to construct a typical full bridge circuit. The light intensity in indoor is able to be set as you wish with a wide adjustable range from 0~100% in theory. The light tracking circuit always works if the output voltages across these two sensors are different. The final implemented control circuit is demonstrated in Fig. 9.

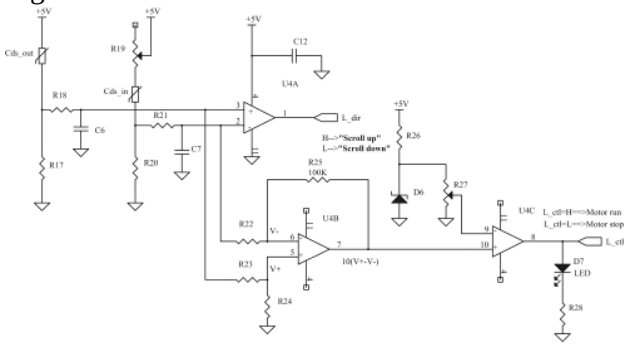


Fig. 9 Diagrams the light tracking circuit.

2.1.6 Power module

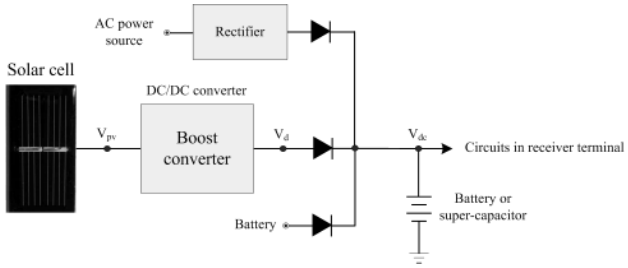


Fig. 10 Shows that solar-cell power module.

The implemented electric aluminium blinds can be supplied with three types of power source such as AC adaptor, battery, and solar cell. The generated voltage value, V_{pv}, of the solar cell is proportional to the light intensity of sunshine. This means the voltage value V_{pv} of solar cell is variable. Therefore, the power source of solar cell can not be directly applied to the later electric circuit. For the sake of reducing the size of the used solar cell, a voltage boost converter is often used to increase the supplying voltage of the solar cell. Two special purposes are anticipated to be achieved here. The first purpose is able to increase the supplying

voltage value of the solar cell. The required time when a rechargeable battery is charged with solar cell is as soon as possible. The second purpose is hoped to overcome a problem that the output voltage of solar cell is variable and it is affected by the environmental light intensity. The latter problem will be solved by adding an energy-saving device to temporarily save the generated power source of the solar cell. For example, a super-capacitor or rechargeable battery is a very suitable device for achieving this purpose. Moreover, the worse load regulation often occurred in most of solar-cell supplying circuits would also be improved as well.

In order to reduce the designed and implemented complication of system controller, the electric aluminium blinds is able to be powered by a group of solar cell which is composed of four pieces of single solar cell and connected in series. The total rated open voltage across output terminals of solar cell, V_{oc}, is about 10 V and the rated short current is 150 mA. A diode D is arranged between the solar cell and super-capacitor to avoid discharging when the output voltage value of solar cell is lower than that of super-capacitor. According to the theoretical formulas, $Q = C \cdot V = I \cdot t$, which is reserved in the super-capacitor, the capacitance and reserved electrical quantity of super-capacitor can be obtained under the required power energy of electrical circuit. (where C is the capacitance of super-capacitor, V is the voltage across the super-capacitor, I is rated current, and t is the working time)

However, most of heavy load like inductive or capacitive load, the stating current is always larger than that of normal rated current. In order to stabilize the output voltage of power source, an energy buffer such as rechargeable battery like Ni-H battery or Li-ion battery is required. Since these rechargeable batteries have higher energy density, although their power energy may be is low. The other type of electric energy reserved device is the super-capacitor. The power density of the super-capacitor is very outstanding. The number of recharging times of the super-capacitor is very short. These devices are allowed to discharge and charge under a very short required time interval. The allowed charging and discharging current is about hundred times that of each type of rechargeable batteries. Especially, some important features such as high charging rate, compact, and intolerance to cold are very remarkable too. The required biggest power energy of the electric circuit is dissipated by DC motor. Fortunately, the total spent time for the DC motor moving from the bottom to top is not more than one minute. Therefore, the dynamically generated electric power of solar cell has been sufficient to supply with the required electric energy of all electric circuit. In recent year, lots of domestic manufacturers are able to design and produce mnay types of super-capacitor. Of course, the cost of super-capacitor would be decreased year by year.

3 Designing Procedures of Solar Cell Module

As mentioned earlier, the required power of the electric circuit can be supplied with an AC power line through an adaptor or a rechargeable battery or a group of solar cells. In case of the power of electric circuit is supplied with a group of solar cell, the supplying voltage of solar cell is decided to the outdoor light intensity. As we known, the light intensity of outdoor sunshine is changeable; therefore, the output voltage value is naturally variable too. In order to overcome this problem, the generated electric energy should be stored in an electric energy reserved device in advance. When the system control of electric aluminium blinds is turned on, the stored electric energy in device will be used to supply with the electric circuit. The designing procedures regarding to the detailed circuits for storing the generated electric energy of solar cell will be described as follows:

Step1: Decides the total dissipated electric energy for one operating cycle: According the measured results from the prototype of electric aluminium blinds, a current value 60 mA will flows through the DC motor when it executed scroll-up action. One operation cycle is composed of one scroll-up and one scroll-down action. The amount of required electrical quantity of the circuit is given as follows:

$$2 \times 60 \times 10^{-3} \times 30 = 3600 \times 10^{-3} \ Coulum \qquad (1)$$

Step 2: Assumes that one day works two cycles: In order to increase the reliability of the system power supply, it is assumed to that the aluminium blinds have to be operated two cycles within one day. Next, the required electrical quantity is stored in reserved device is:

$$2 \times 3600 \times 10^{-3} = 7200 \times 10^{-3} \ Coulum \qquad (2)$$

Step 3: Selects a suitable device to reserve electrical energy: Basically, the total electric quantity which it is required by all control circuits and DC motor as shown in (2). The rated working voltage of the

circuit is assumed as 5.4 V, the capacitance of super-capacitor can be calculated as follows:

$$7200\times10^{-3} = C\times5.4$$
$$\therefore C = 1.333\ F \quad (3)$$

Here, we want to further improve the reliability of the system power supply. A super-capacitor with 5 F is used as the electric energy storing device here.

Step 4: Selects a solar cell with suitable specifications: The required solar cell is that should supply with sufficient electrical energy to all electric circuit designed in electric venetian blind. The rated open voltage is (V_{OC}) 4 V and the short-circuit current is (*Isc*) 75 *mA*, respectively. If the total working time for one day is five hours and the generating efficiency must be over 60 percentages. By using these electrical specifications, the generated electric power energy of solar cell for every day can be calculated in the following:

$$4\times75\times10^{-3}\times0.6\times5\times60\times60 = 3240\ Joul \quad (4)$$

If the capacitance value of the super-capacitor is $5\,F$, the rated working voltage is assumed as $5.4\,V$. The allowable charged electrical energy must be sufficient to supply with all circuits required electric energy for two operation cycles, then

$$W_C = \frac{1}{2}\cdot C\cdot V^2$$
$$= \frac{1}{2}\cdot 5\cdot 5.4^2 \quad (5)$$
$$= 72.9\ Joul$$

Apparently, the stored energy shown in (4) is much bigger than that shown in (5), it represents that the amount of generated electric energy of solar cell is sufficient.

Step 5: Independent power supply: Most of electrical energy will be dissipated in the receiver circuits due to the action of DC motor. The amount of generated electrical energy of solar cell will be always enough if and only if a super-capacitor with large capacitance and power density enough. In most application cases, an AC power source through an adaptor are used to supply with the required electrical circuit is not necessary at any time.

Step 6: Indirect operation: the new developed electric aluminium blinds is operated by remote control method. The control command is transferred from the transmitter terminal to the receiver terminal by means of wireless infrared medium. The operator is really not required to control the aluminium blinds by their hand. It is very convenient and suit for the future developing trend in most consumer electronics.

4. Controller

According the functional block of system controller based on wireless infrared medium, the detailed transmitter and receiver circuits designed for controlling the proposed electric aluminium blinds will be gradually examined in the following:

4.1 Transmitter Circuit

Fig. 11 shows that an IC 74HC148 is used to decode a key code into a four-bit data. A communication pair of ICs, HT-12E and HT-12D which are produced by domestic manufacturer, Holtek, is responsible for encoding and decoding data and address. The HT-12E is an encoder IC and arranged in transmitter circuit, it has following important features:

(1) A0~A7: Input pins for address A0~A7 setting;
(2)AD8~AD11: Input pins for address/data AD8~AD11 setting;
(3) OSC1: Oscillator input pin;
(4) OSC2: Oscillator output pin;
(5) /TE: Transmission enable, active low;
(6) Dout: Encoder data serial transmission output;
(7) Vss: Negative power supply, grounds;
(8) Vdd: Positive power supply.

A transmission action is enabled by applying a low signal to the TE pin. The designed purpose of integrated circuit, UN2003A , wants to promote the driving capability of the transmitted signal.

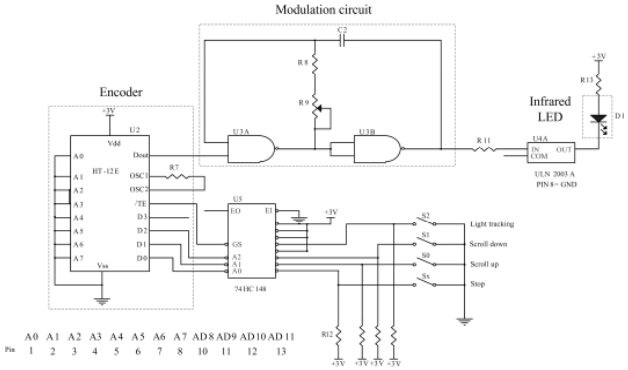


Fig. 11 Detailed transmitter circuit.

When the transmitter circuit is triggered to begin transmitting data, that is /TE pin become low voltage level, the data D0~D3 are being transmitted from Dout pin by serial form. The resting time interval between each transmission is also 12 bits transmitting time. Assuming that the oscillator frequency is 3 *KHz* , that is the period for

transmitting one bit is 3 *msec*, the total spent time for transmitting 12 bits is about 36 *msec*. A transmitted data will be repeated four times and then waiting for the same time. Therefore, the total spent time for transmitting 12 bits is 2(4 x 36)=288 *msec*. As shown in Fig. 12, it is the working flowchart of HT-12E.

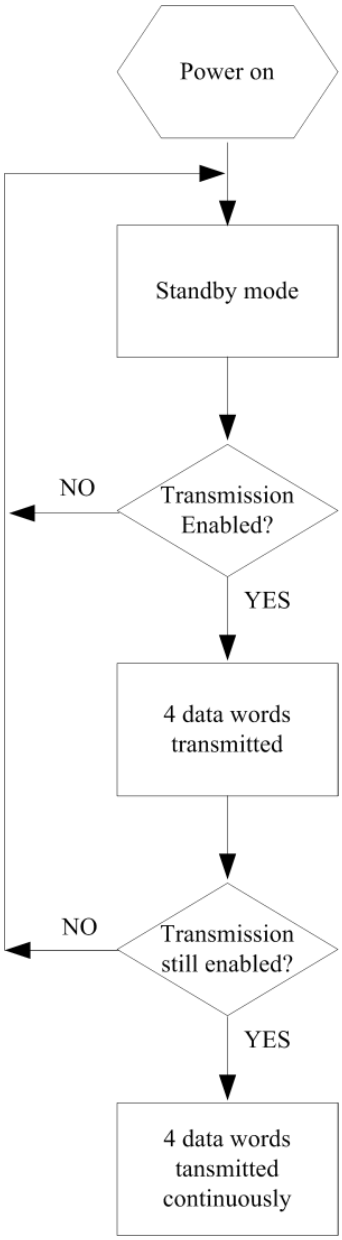


Fig. 12 Working flowchart of integrated circuit HT-12E.

4.2 Receiver Circuit

The HT-12D is a decoder IC and arranged in receiver circuit. The receiver circuit is composed of a decoder IC, a single chip, and a few passive devices. The operation principle of receiver circuit is described in the following.

The receiver circuit of electric venetian blind is shown in Fig. 13. It consists of a group of solar cell, infrared receiver module, decoder IC, single chip and status display, current sensory circuit, light-intensity tracking circuit, and a counter for measuring the moving length of electric venetian blind. As can be seen in Fig. 13, the main part of the receiver circuit includes an infrared receiving module, decoder IC, and an 8-bits single chip. The output signal of infrared receiving module is reverse first for coming back the data like in transmitter terminal and then transmitted to the input pin of decoder IC. On the one hand, the decoder IC will compare the received address to the default address; on the other hand, it will output data from the received data if and only if four times of address comparison is equivalent.

As mentioned above, HT-12D is a communication pair of integrated circuit, HT-12E. It is used as for decoding the received data and address which transferred from remote control terminal. The main features of this integrated circuit are introduces as follows:

(1) A0~A7: Input pins for address A0~A11 setting;
(2) D0~D3: Output data pins;
(3) OSC1: Oscillator input pin;
(4) OSC2: Oscillator output pin;
(5) VT: Valid transmission, active high;
(6) Din: Serial data input pin;
(7) Vss: Negative power supply (GND);
(8) Vdd: Positive power supply.

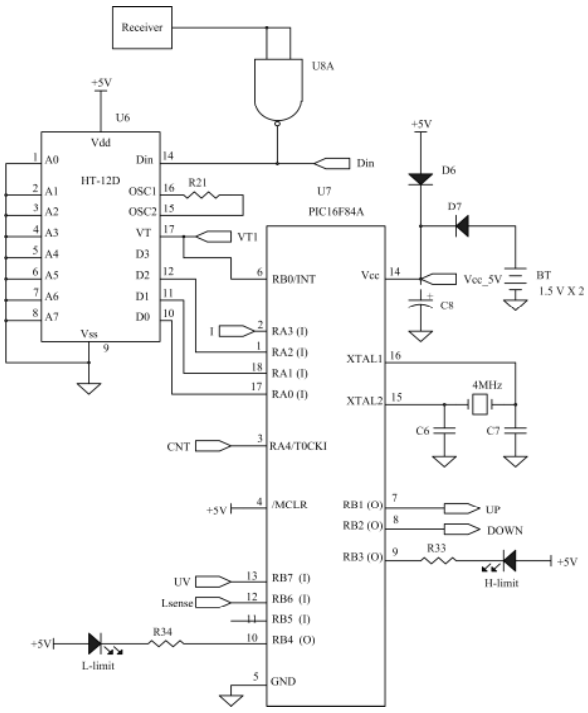


Fig. 13 The detailed receiver circuit.

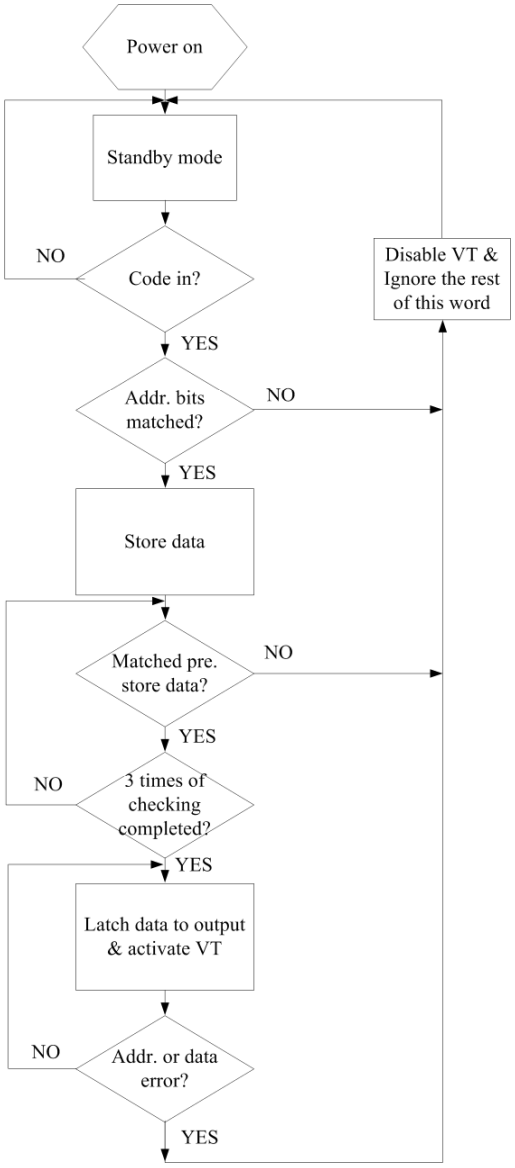
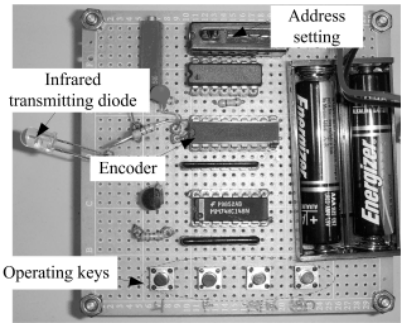


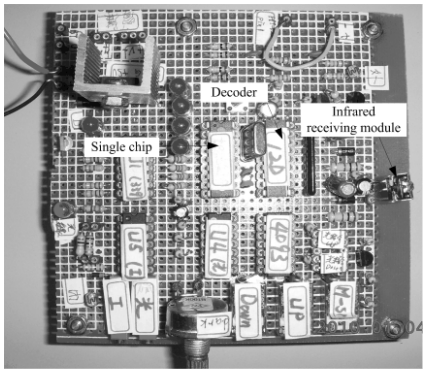
Fig. 14 Working flowchart of the decoder IC in receiver terminal.

5. Experiments and Discussions

According to the required functions in the respective transmitter and receiver terminal circuits, Fig. 15 shows the completed prototype of electric aluminium blinds. Fig. 15(a) is the prototype of remote control circuit or transmitter. Fig. 15(b) is the prototype of receiver circuit or receiver. Fig. 16 demonstrates the experimental process that the electric aluminium blinds is powered by a solar cell. The generated electrical energy of the solar cell on the one hand charges the super-capacitor, on the other hand supplies with the required electrical power of all the circuits in receiver terminal. As shown in Fig. 17, after the electric aluminium blinds has been completed, the circuit in remote control terminal or transmitter is powered by a group of battery when the circuit in receiver terminal is supplied with an AC adaptor. The electric aluminium blinds is operated by an indirect or non-touch method through an infrared wireless communication. Especially, the maximum communication distance is over ten meters. This transmission distance is sufficient to the remote control requirement for the electric aluminium blinds or the other remote control applications of popular electronic appliances. The *NEC* Infrared remote transmission format is used as command or data transmission standard of the proposed electric aluminum blinds.



(a)



(b)

Fig. 15 The photographs of completed prototype (a) transmitter circuit (b) receiver circuit.

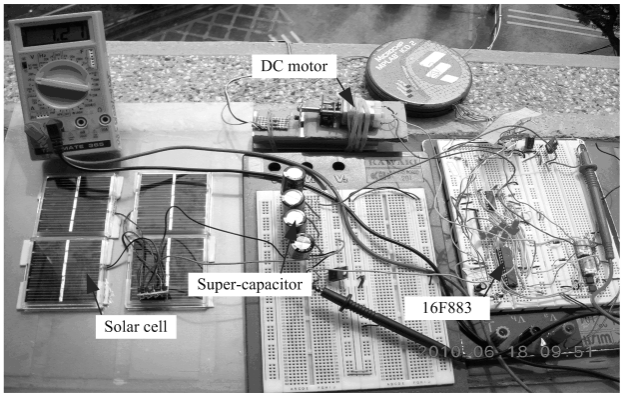


Fig. 16 The photograph of a completed receiver circuit which includes solar cell, super-capacitor, and related control circuits.

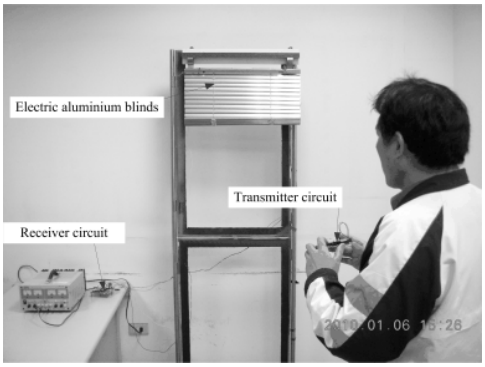
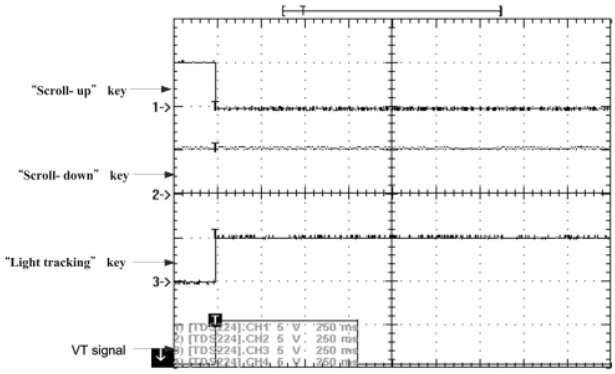
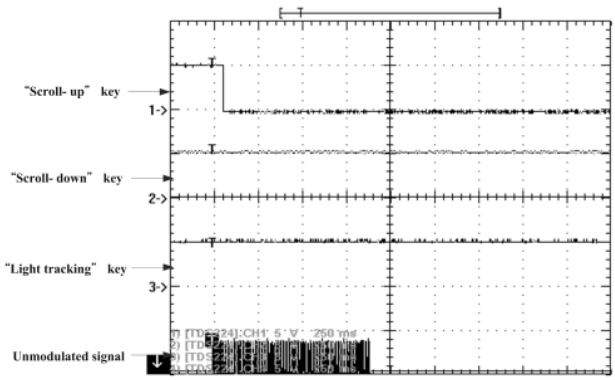


Fig. 17 The photograph demonstrates the experimental process during testing the completed prototype.

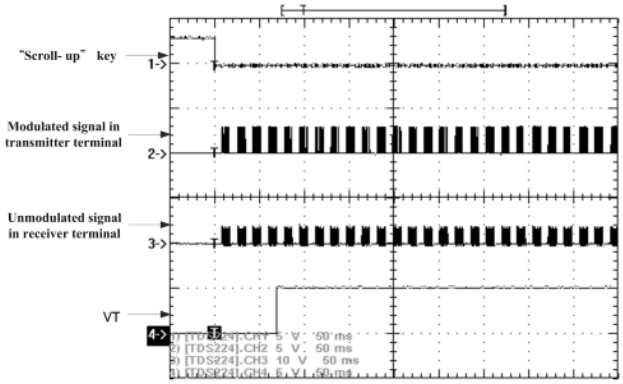
Fig. 18(a) demonstrates the action of electric aluminium blinds when a scroll-up command is set and transferred from the transmitter terminal. The key data is first compliance with the address data and then formed as a series of pulses. In order to increase the communication distance of infrared transmitter, the output pulses of encoder IC is modulated by an oscillator with high working frequency again, as shown in Figs. 18(b)~18(d). The pin Dout of encoder IC is an output and connected to a modulation circuit which is composed of inverse NAND gates, resistor, and capacitor. During the high voltage level, the CH2 and CH3 waveforms shown in Fig. 18(c) show that the modulated signal is generated by modulation circuit.



(a)



(b)



(c)

Fig. 18 Shows some important measured parameters' waveform in transmitter (CH1 and CH2) and receiver terminals (CH3 and CH4), respectively.

From the shown waveforms in Fig. 18, the demonstrated the functions or results related to the implemented prototype control circuits are agree with the anticipated designing goal well.

6 Conclusion

One compound power source supplying structure is designed and implemented in this paper. All the required electrical energy of the proposed control method of electric aluminium blinds can be supplied with one of the power supplies at the same time. The final choice of the power source is decided to the personal custom of owner and the provided environmental power supply. When the user wants to operate the electric aluminium blinds, he or she need not touch the electric aluminium blinds directly and just control it by remote method. This is a convenient and save-time operating method. Many consumers who are always pursue high living quality must be satisfied with this control method. Take the manufacturing cost into consideration; the infrared wireless control method is selected as the remote control method. All the commands are transferred from transmitter terminal to receiver terminal. Under the allowable communication distance, any type of electric aluminium blinds is able to be controlled by using the same infrared transmitter and receiver circuits. Regardless of the controlled weight and volume of the load, the robustness of proposed control method here is very outstanding. Moreover, the electric aluminium blinds is often installed without destroying any building structure. The user can almost be controlled the default actions of the electric aluminium blinds at any place of indoor building. Besides the point-to-point control, many electric aluminium blinds can also be controlled by means of broadcast method at

the same time. Much more time will be saved by people. In other words, the operating efficiency would be improved or increased.

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