

16 * 16LED Dot Matrix Display

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Abstract: This design uses a simple single-chip AT98S52 as the main control module, the use of simple external circuit to drive 16 * 16 dot matrix LED display. The use of burner can be very convenient to achieve the microcontroller and PC and other peripheral storage device data transmission, and can use the software to facilitate the display content of the diverse changes, on the other hand dot matrix display widely used in hospitals, airports, banks And other public places, so that the release of information into the dynamic screen era, so the design has a strong practical application.

Keywords: Dot Matrix; LED; Microcontrollers

1. Introduction

1.1 Overview

LED electronic display is with the computer and related microelectronics, optoelectronic technology and the rapid development of the formation of a new type of information display media.^[9] It uses light-emitting diodes to form a dot-matrix module or a pixel unit to form a variable area display screen. With high reliability, long service life, strong environmental adaptability, high cost performance and low cost, short ten years, the rapid growth of flat panel display of mainstream products, in the field of information display has been widely used.^[5]

1.2 Introduction and composition of LED

LED (Light Emitting Diode) that light-emitting diode is the use of semiconductor P-N junction electroluminescence principle made of semiconductor light-emitting devices.^[9] LED has a high brightness, low power consumption, long life, low operating voltage, easy to miniaturization and so on.^[4] In recent years, it has been developed rapidly and widely used. From the seventies, has been started with LED as a light-emitting pixels developed LED display. With the development of computer technology and LED devices mature, LED

display has also been rapid development. Has developed a variety of specifications of the LED screen, from the color of a monochrome, multi-color, full color display, from the display size speaking, LED screen has been done hundreds of square meters. Previous study^[4] has now formed a new high-tech industry. Recently, blue, pure green ultra-bright light-emitting diodes have been successfully developed and commercialized, made of LED outdoor 'big color TV' has become a reality, it marks the LED display technology has reached a new height.

LED display is made of light-emitting diodes for the display of the display screen, limited by the space, suitable for a few square meters to hundreds of square meters of the screen, in this range and several other compared to the screen has a strong advantage, Can express text, graphics, images, animation and video, can better adapt to a variety of use of the environment.^[5]

LED display system generally by the computer, send control panel, receive control panel, display screen body, power supply, metal frame and other components.^[5]

(1) Microcomputer

Microcomputer is mainly used for large-screen

system operation and control, reflected in the upper part of the software. Used to make, edit the content to be displayed, including text, images, forms, and set the various programs to play the order and screen dwell time. When the editing is complete, the computer is used to run the contents of the play. When the microcomputer is playing, the contents are displayed on the computer's display.

(2) Send the control board

The role of this part is mainly to display the contents of the computer down, the data processing and transformation, converted into a large screen display required data format, and the signal power amplification to send to the distant big screen.

(3) Receive the control panel

The role of this part is to send the control panel to send the data received and sent to the corresponding position on the big screen.

(4) Display screen body

The display screen body is mainly composed of LED luminous tube matrix and drive circuit. It receives the control panel to receive the data signal sent to the front of the display LED LED tube light off, so that the big screen shows a picture.

1.3 Classification of LED screen^[5]

According to the display color can be divided into

Single color display: single color (red or green).



Figure 1.1; Single color display.

Dual color display: red and green dual color, 256 gray, can display 65,536 colors.



Figure 1.2; Dual color display.

Full color display: red, green, blue three primary colors, 256 gray full-color display can display more than 16 million colors.

Sort by display device

LED digital display device is for the 7-segment digital tube, suitable for making the clock screen, interest rate screen, display digital electronic display.

LED dot matrix graphic display device is composed of a number of evenly arranged light-emitting diode dot matrix display module, suitable for playing text, image information.

LED video display device is composed of many light-emitting diodes, you can display video, animation and other video files.

Classification by usage environment

Indoor display: luminous point is small, generally $\Phi 3\text{mm} - \Phi 8\text{mm}$, the display area is generally a few dozen to ten square meters.

Outdoor display: the area is generally tens of square meters to several hundred square meters, high brightness, can work in the sun, with wind, rain and water

Classification by luminous spot diameter

Indoor screen: $\Phi 3\text{mm}$, $\Phi 3.75\text{mm}$, $\Phi 5\text{mm}$ that is P7.62mm, $\Phi 8\text{mm}$

Outdoor screen: $\Phi 10\text{mm}$, $\Phi 12\text{mm}$, $\Phi 16\text{mm}$, $\Phi 19\text{mm}$, $\Phi 20\text{mm}$, $\Phi 21\text{mm}$, $\Phi 22\text{mm}$, $\Phi 26\text{mm}$

Outdoor lighting unit is the basic unit for the luminous tube, the principle of the luminous tube is a group of red, green and blue light-emitting diodes sealed in a plastic tube common hair

Sort by display

There are static, horizontal scroll, vertical scroll and flip display. Single block module control drive 12 (up to 24 blocks) 8X8 dot matrix, a total of 16X48 dot matrix (or 32X48 dot matrix), is a single MAX7219 (or PS7219,

HD7279, ZLG7289 and 8279 and other similar LED display driver module) 3 LED display technology

2. LED dot matrix display

2.1 LED display of the proposed

LED display is the late eighties in the global rapid development of the new information display media, which uses light-emitting diodes consisting of dot-matrix module or pixel unit in the area display screen, with high reliability, long life, and environmental adaptability. The price performance is higher, the use of low cost characteristics, in a short period of ten years, the rapid growth of flat panel display of mainstream products in the field of information display has been widely used.

2.2 LED display needs analysis

The development of modern information display technology, the formation of the CRT, LCD, PDP, LED, EL, DLP series of information display products, look at all kinds of display products, each have their own strengths and appropriate Market application requirements. With the LED material technology and technology to enhance the LED display to highlight the advantages of flat panel display one of the mainstream products, and in many areas of social economy has been widely used, including:

(1) Securities trading, financial information display

LED display in this area accounted for a few years ago the domestic demand for more than 50% of the LED display, there is still a large demand.

(2) Airport flight dynamic information display

Civil aviation airport construction requirements for the residence is very clear, LED display is the flight destination display system FIDS (Flight information Display system) of choice for products.

(3) Port, station passenger guide information display

It is an important content of the development and transformation of the domestic railway station and the port technology. The information system and the broadcasting system, the train to the revealing system, the train to the revealing system and the ticketing information system together constitute the automation system of the passenger hub.

(4) Sports venues information display

LED display as the game information display and

live broadcast of the main means has replaced the traditional lighting and CRT display, in the modern sports venues to become the necessary competition facilities.

(5) Road traffic information display

The emergence of intelligent efficiency system (ITS), in the city, highway and other fields, LED display folk as a variable intelligence board and speed limit signs, have been widely adopted.

(6) Scheduling command center information display

Power dispatching, vehicle dynamic tracking and vehicle height management are also gradually using high-density LED display.

(7) Postal, telecommunications, shopping malls and other services in the field of business promotion and information display

(8) Advertising media new products

In addition to a single large indoor and outdoor display as advertising media, the cluster LED display advertising system, the train LED display advertising system has also been adopted and is being promoted.

(9) Performances and rallies

Large-scale display more and more popular for public and political purposes of the video broadcast, such as the 50th anniversary of the founding of our country Daqing, the world's new millennium celebration and other major festivals, large-scale display in the live and advertising information release play the role of excellence.

(10) Exhibition

LED display large screen as an exhibition organizer to provide one of the important services to provide exhibitors with paid services, there are some large foreign LED large-screen professional leasing companies, there are some large manufacturers to provide rental services.

2.3 LED display development environment

Display drive circuit selection

Option 1 in the use of a dedicated LED control chip without the use of general-purpose chip 74LS595, which has 8-bit latch, string - and shift register and tri-state output, you can use its latch function to achieve the hardware circuit to refresh the data The It is characterized by simple control signal, cascade convenience, the number of small chips.

Option 2 We can use the shift register 74HC164 and the decoder 74HC138 with the triple tube to achieve the LED dot matrix display of the ranks of control. But because the transistor needs too much power overload, will lead to the screen dark.

Considering that we adopt program one.

Brightness continuously adjustable

Scenario 1 by adjusting the refresh rate in the software. When the refresh rate is high, the time of continuous lighting is short and the display brightness is low. When the refresh rate is lowered, the time of continuous lighting is prolonged and the display becomes bright by adjusting the duty cycle to achieve the brightness adjustment of the display. However, due to software adjustment brightness changes are not continuous. It cannot achieve continuous brightness adjustment and there will be flickering. The effect of regulation is not obvious.

Option 2 by adjusting the potentiometer to change the voltage, to achieve brightness adjustment. Adjust the potentiometer to achieve linear voltage adjustment, thus controlling the transistor to make the display voltage drop to change to achieve the purpose of continuous adjustment of brightness. Potentiometer adjustment range is large, so use this method to adjust.

We consider the program II.

Selection of serial port

Option 1 The RS-485 bus communication mode is widely used because of its simple structure, low cost, communication distance and data transmission rate.^[2] But the RS485 bus exists from the point of view of the long-distance (1200M) Such as failure to pay attention to some of the details of the deal, often failure of communication or even system failure and other failures and the bus itself there are many limitations, low efficiency, poor real-time, low reliability, poor application.

Option 2 Uses MAX232 for serial transmission, the benefits of serial communication is simple, strong anti-interference. Because the system has a register, so do not need long-distance transmission, so MAX232 is sufficient to meet the requirements. And can be directly and PC interface,^[2] do not add protocol conversion circuit.

In summary, program two is more reasonable.

3. System design and implementation

3.1 The overall system diagram

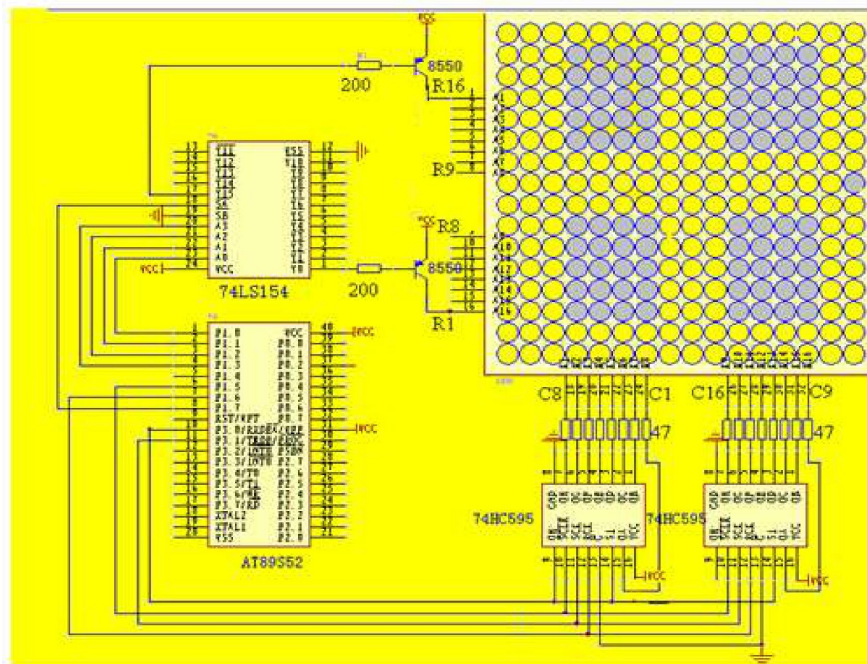


Figure 3.1; System schematic.

3.2 Hardware conditions

The commonly used AT89S52 control is more

skilled and widely used.^[9] Now 51 series of technical hardware development is also very fast, there have been

many very powerful single-chip, so the use of single-chip can achieve the basic functions required.

Are 8051 kernel, but 52 of the internal resources than 51 a little more,^[8] such as the addition of a 16-bit counter T2, of course, the corresponding special register (SFR) also has a little change, and 52 of the memory from 51 Of the 128 bytes to 256 bytes, ROM from 2K to 4K, you can install a larger program, but if the single from the speed of operation, because both are 8051 immediate descendants, basically can be considered two The same computing performance.^[1]

Taking into account the increase in memory on the benefits of more complex procedures, 52 of the overall performance is much better than 51.^[1]

In addition, S52 than the C51 also increased the ISP function,^[1] is the online programmable function, which is a very useful feature, the first is to save the money to buy the programmer, in addition, for the simulator cannot afford or hope to board Debugging (that is, inserted in the finished circuit board debugging) is very valuable, you can always update the circuit board inserted in the microcontroller program, very convenient. Of course, S51 also have this feature, C51 and C52 are not available, but they have also been discontinued,^[7] now the electronics market can buy mostly S series.

Using four 8 * 8LED display module, constitute 16 lines * 16 column dot matrix display dot matrix display. 4 8 * 8 dot matrix LED display module uses a bus-shaped to form a 16 * 16 LED dot matrix, for the simultaneous display of a 16 × 16 dot matrix Chinese characters or four 16 × 8 dot matrix letters, characters or numbers.^[4] The unit display screen can receive data information and command information from the controller (main control circuit board) or the upper display unit module and transmit the data information and the command information without any change to the lower display module unit, so the display panel can be extended to more display units for displaying more display content.

3.3 Software section

LED display drive circuit^[4]

Using 74HC154 decoder will be out from the AT89S52 column signal through the 74HC154 cascade 16-bit signal output connected to the 16 * 16 dot matrix LED input, as the lattice line drive signal. From the

89S52 output four signals were input to the cascade 74HC154 decoder,^[2] and then output 16-bit line signal, after 16 200 ohm resistor, and then input to the 16 PNP (8550) transistor B pole to carry out On the line signal amplification, where all the transistor E pole connected to + 5V power supply, all the C pole 16 LED dot matrix line type pin, the signal as a dot matrix LED line input signal. Through the control of the four input signals of 154, change the line signal to control the diode light, off to show the required characters, Chinese characters.

Line drive circuit: each LED tube needs 7mA of current, then 64 at the same time you need to 448mA current, so we have to drive the column, we use the transistor 8550 column signal amplification, LED dot matrix to normal display drive circuit is as follows:

LED display column drive circuit^[4]

This circuit is composed of two cascaded 74HC595 integrated circuit, it has an 8-bit serial and out of the shift register, you can achieve the column in the display of data at the same time, the next row of data transmission.

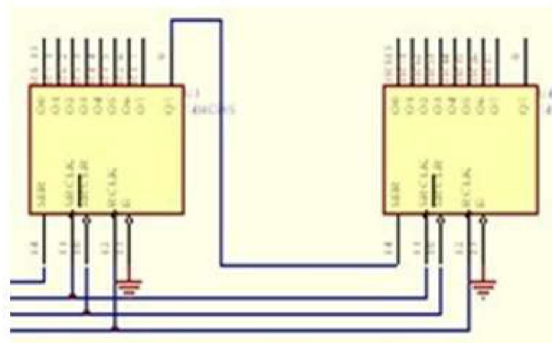


Figure 3.4: 74HC595 column drive circuit diagram.

3.4 Brightness continuously adjustable

With a 200 ohm resistor and a 8550 transistor, the voltage drop of the LED can be adjusted to achieve continuous change in brightness.^[5] This is the method of adjusting the brightness.

3.5 Calculation of refresh rate

According to the visual characteristics of the human eye, 50HZ is the appropriate refresh rate, so the CPU refresh rate is generally not less than 60HZ, but the refresh rate is too high, then the display will reduce the brightness, so the refresh rate has the highest value requirements. The design of the maximum refresh rate is

600HZ.^[1]

3.6 Keyboard

The keyboard is to use a relatively simple stand-alone keyboard, and has a function module circuit diagram.

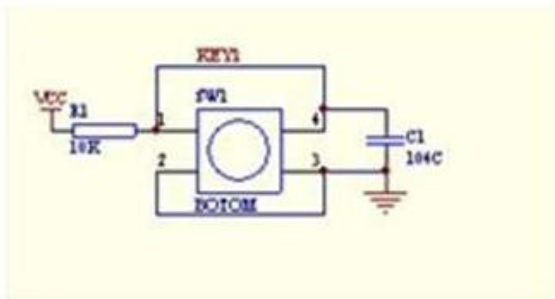


Figure 3.5; Pushbutton switch diagram.

The functions of the keyboard are as follows:

Display mode key: key mode can choose five modes, stored in Chinese characters, stored symbols, SD card information, clock and PC data display.

Scroll mode key: you can control the two scroll mode, in the normal display mode to achieve left and right scroll.

Loop mode key: You can control the timer mode.

Time adjustment key: the time setting button, in the clock display mode, can be used with the addition and subtraction key cycle setting, minutes, seconds.

Timing key: When pressed, the time of the current cycle interval is displayed, and the interval control can be adjusted by the addition and subtraction key.

Refresh the frequency key: press, display the refresh rate, you can use the plus or minus key to adjust.

Scroll speed key: press to display the current speed, use the plus or minus key to adjust the rolling speed.

Plus, minus key: with other keys, in a variety of modes, to achieve adjustment.

Reset key: Reset the system.

3.7 Software aspects

The system's display processing using dynamic scanning method, and keyboard processing using the query method and pay attention to the key of the shaking processing. The whole program can be divided into keyboard scanning, dot matrix line scan, serial transmission.

Key program

The key program in this system is divided into key

scanning subroutine and key function execution subroutine, but also in the key used in the timer Time0 to achieve the function of the key to shake.

Scanning of ranks

The system uses 89S52 to achieve the ranks of the dot matrix display scan, the software flow chart as shown below

4 AT89S52 part of the main program code^[2,3,6]

The following program is the main function:

Void main (void)

{SCON = 0x00; // serial port operating mode 0:

shift register mode

TMOD = 0x01; // Timer T0 works in 1:16 bit mode

TR0 = 1; // start timer T0

P1 = 0x3f; // P1 port initial value: allow receive,

latch, display

IE = 0x82; // allow timer T0 to be interrupted

P2 = 0x00; // P2.0 connected to the radio receiver

module in the first 11 feet (B key), P2.1 then 12 feet (C key), P2.2 then 13 feet (D key), initialized to no

// press the button

While (1)

{If (P2 \u0026 0x04) diyizhan (); // that is, if the P2.2 feet appear high, indicating that the D key is pressed, dot matrix show Yu workers three schools to the

Else if (P2 \u0026 0x02) dierzhan (); // that is, if the P2.1 pin appears high, indicating that the C key is pressed, dot matrix show Yu Institute of Technology to the

Else if (P2 \u0026 0x01) disanzhan (); // that is, if the P20 feet appear high, indicating that the B key is pressed, dot matrix show discount area to the

} // end while (1)

Delay (3000);

For (i = 0; i <7; i++) // Display: left horse

{For (j = 0; j <2; j++)

For (k = 1; k \u0026 lt; 9; k++)

{For (l = 0; l <16; l++)

{Dispram [l * BLKN] = dispram [l * BLKN] << 1 | dispram [l * BLKN + 1] >> 7;

Dispram [l * BLKN + 1] = dispram [l * BLKN + 1] << 1 | yi [i] [l * BLKN + j] >> (8-k);

4. Results and analysis

4.1 Basic functions

The functional tests	Results of the test
LED display	Achieve a 16 * 16 dot matrix display
The display does not flicker, brightness is moderate	To meet the requirements
Key control to switch numbers and letters	To achieve this function
Can show specific Chinese characters and characters	Can be achieved

Table 5.1

4.2 To play part of the function

Function	Is the function implemented? description
Brightness continuously adjustable	Achieved
Scrolling display	Can achieve left and right scrolling
Stored information	Can be extended to 4 groups (4 or 8 characters for each group)
Power-down protection	Can be achieved

Table 5.2

4.3 Other play parts

Function	Is the function implemented? Description
Multi-font display	Implementation, non-preset information can choose two different fonts
Scrolling display	To achieve the upper and lower scroll
Yin and yang words	Achieved
The mixed display implements the character Chinese characters mixed	display
Loop	To achieve a number of information linked to the beginning and left, continuous horizontal left rolling display

Table 5.3

5. Conclusion

The system completed the LED dot matrix electronic display and controller production. After debugging, the display display brightness is moderate, and can achieve continuous adjustable, scrolling display and real-time display. Through the communication with the PC, so that the information displayed in real time to update. The whole system is simple, reliable, stable performance. The system has met the basic requirements of the design and to play a part of the requirements, and in other projects to expand a lot of design.

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