LED Display System Design Based on Single Chip Microcomputer

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Abstract

The LED display monitor is uses the light emitter diode lattice module or the picture element unit composition plane formula screen. It is made of a number of independent LED light-emitting diode packages, which can display Chinese characters, numbers and symbols. It usually used to display text, time, speed, system status and so on. This paper presents the design scheme based on AT89C52 64 × 32 dot matrix LED display, the principle is the character font code to be displayed is stored in a storage space, the microcontroller by reading the font and make the appropriate treatment, in a different way then displayed on the dot matrix display screen.

Keywords

LED display system, AT89C52, 74HC595, Line and column driver.

1. Introduction

With the continuous development of LED technology as well as LED's advantages of low power consumption, long service life, environmental protection etc., LED application fields is gradually increasing, especially application of LED dot matrix display. With the high-speed development of information industry, as a significant means of information dissemination, LED display has become a shining sign for modern information-based society. In recent years, LED display has been widely applied public places needing propaganda such as postal service halls, bus stops, ports and stadiums [1]. At present, the LED electronic display is developing in the directions of higher luminance, higher reliability, being panchromatic and multimedia; system operation and maintenance also develop in the directions of networking and intelligence.

2. Overall structure of LED display system

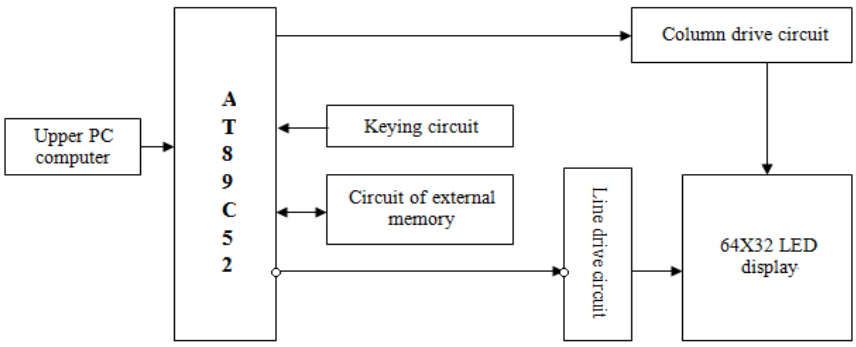

Fig. 1 Overall structure of LED display system

LED display, which integrates photoelectronic technology, micro electronic technology, computer technology and information processing technology, can be used to display words and graphs synchronous with the computer screen [2]. LED display system can be divided into three parts including the SCM system and peripheral circuit, line drive circuit and column driver, as well as LED dot matrix array, as shown in Fig. 1.

3. Hardware design of LED display system

3.1 Design of line drive circuit.

74HC154 is used as the line drive chip of LED display. Because the specification of LED display is 64×32 in this design, two 74HC154 chips are required. The schematic diagram of line drive circuit is shown in Fig. 2.

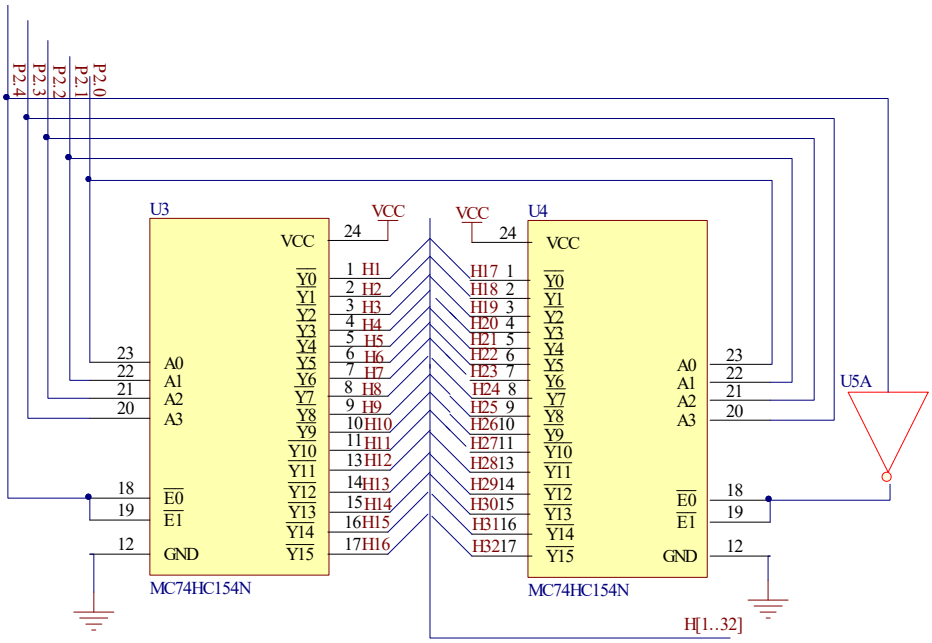

Fig. 2 Schematic diagram of line drive circuit

The SCM's P2.0−P2.3 ports are connected with 74HC154 decoder's A0−A3 output terminals. When SCM system controls its P2 pin output 0x00−0x0F, according to the working principle of decoder, output terminals $\overline{Y_0} - \overline{Y_{15}}$ respectively output low level and the first line to the sixteenth line on the display are selected successively; the SCM's P2.4 port is connected to the enabling end of 74HC154 decoder (controller of 1st to 16th lines); meanwhile, P2.4 port is connected to the enabling end of the second 74HC154 decoder (controller of the 17th to 32nd lines) to guarantee the realization of line scanning; when scanning from the first line to the sixteenth line is finished, P2.4 port's output will change from "0" into "1"; then, enabling end of the second 74HC154 chip is effective and the first 74HC154 stops working; namely, the seventeenth line of LED display is selected to realize the scanning of the lower half screen of LED display.

3.2 Design of column drive circuit.

74HC595 is used as the column drive chip of LED display. Each 74HC595 can control 8 display columns. Since there are 54 columns in LED display designed in this system, eight 74HC595 chips are required. 74HC595 connects clock control signals through series connection. The Q7 pin of last 74HC595 chip is connected to the data input terminal DS of next chip, so when the parallel output pulse is effective, all column signals will be emitted synchronously. The schematic diagram of column drive circuit is shown in Fig. 3 below.

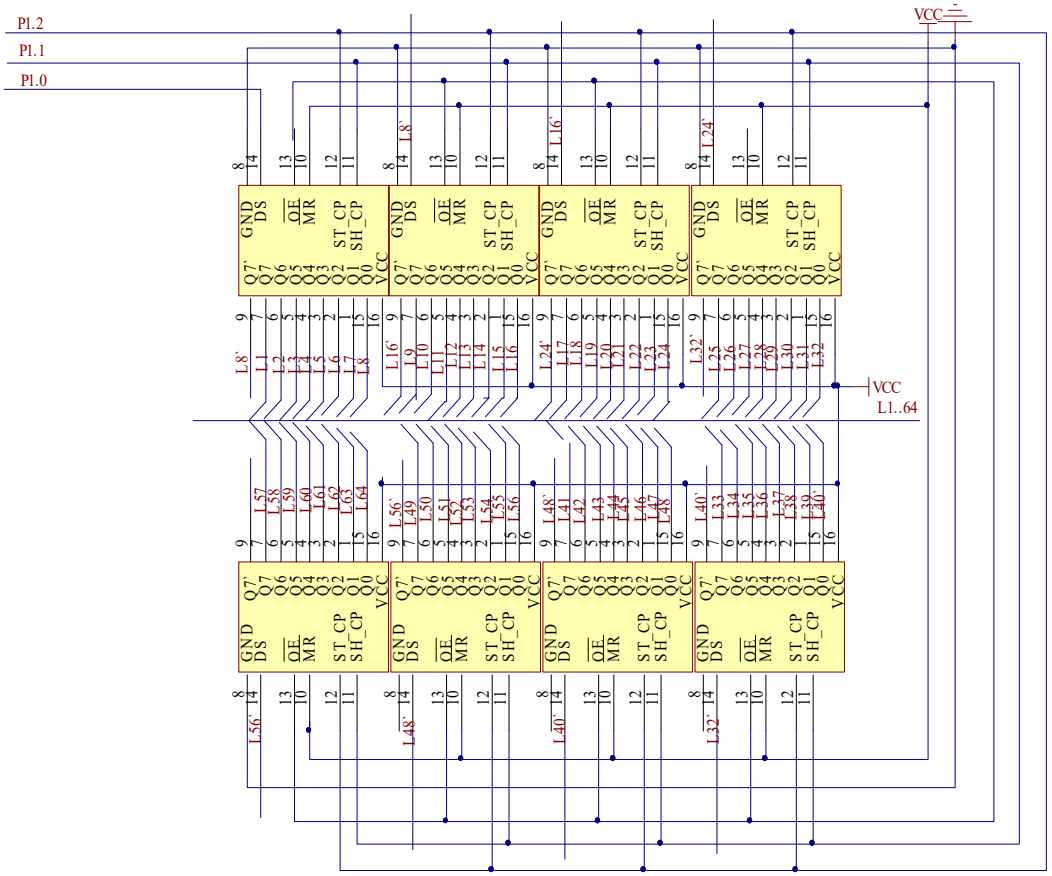

Fig. 3 Schematic diagram of column drive circuit

Each Chinese character is composed of and displayed by the dot matrix with 16 lines and 16 columns [3]. Namely, each character in the national standard Chinese character library is denoted by the 256 dot matrix. The dot matrix code generated by matrix software is the hexadecimal number with 8 bits as a group. Since line scanning is adopted in this design, the horizontal matrix code is used. When the code of each character is controlled by 74HC595, data from first line to the eighth line of 8 characters are outputted in series through Pl.0 port of SCM with the upper bits ahead of the lower bits. Such transmission method is related to circuit connection and the working principle of 74HC595. SCM's Pl.2 port outputs the shift clock. When each bit of data is inputted from P1.0 port, the electric level of Pl.2 changes from high level to low level and the content in shifting register of 74HC595 shifts from the upper bit to a lower one. When the 9th bit of data is sent to the DS end of 74HC595, the Q7 of 74HC595 will serially output the first bit of data from shift register to the first bit of next 74HC595. New data are transmitted to the 8th bit. When all data from the 1st line to the 64th line are prepared well, P1.1 will generate a rising edge pulse to be delivered to the ST-CP pin of 74HC595; the cascading pins of parallel output clock of 74HC595 chips are connected in series and controlled by P1.1, so column data of each 74HC595 can be outputted synchronously at the arrival of output clock.

The column drive chip and line drive chip control synchronously. When 74HC595 gives out a lock signal, the output pin of line drive chip outputs the line of data to be displayed; then, the characters of the line are displayed. According to such operation time sequential routine, circulate it from the 1st line to the last line to realize the line scanning; then, all characters on the whole screen can be displayed. The full-screen scanning rate of LED display is higher than 50HZ, eyes' visual persistence frequency, the display screen watched by people are static and complete [4].

3.3 Design of keying circuit.

This system designs and uses four independent keys, which control the switchover among the static, shift-up, shift-left and automatic cycle display statuses. The key interface circuit is shown in Fig. 4.

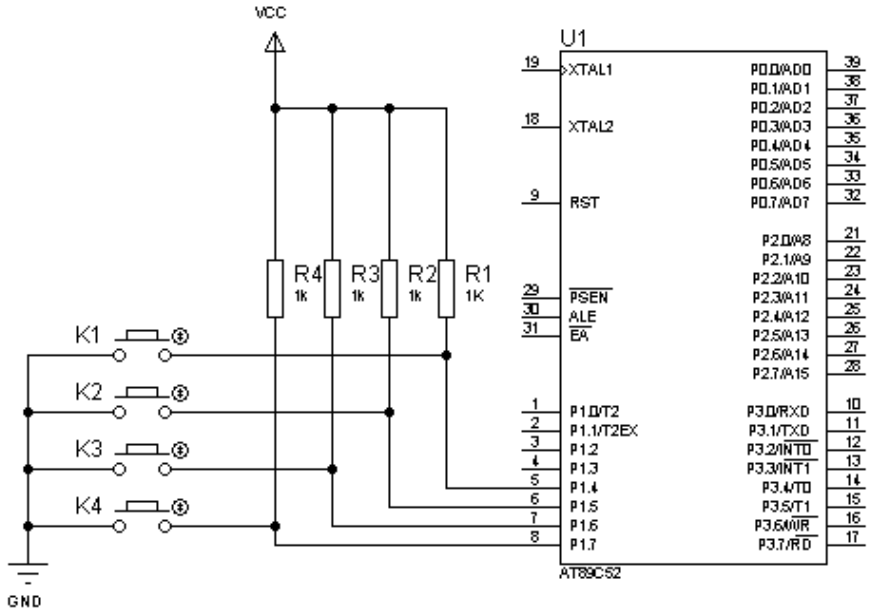

Fig. 4 Key interface circuit

4. Design of LED display system software

4.1 Design of overall system programs.

The system realizes display of Chinese characters and punctuation characters on LED display. Chinese character codes are stored in the ROM of SCM in advance. Programming mainly shows modularization. Each function is programmed with independent subfunctions respectively and corresponding functions can be realized by using the main functions to call subprograms. Main program flowchart is shown in Fig. 5.

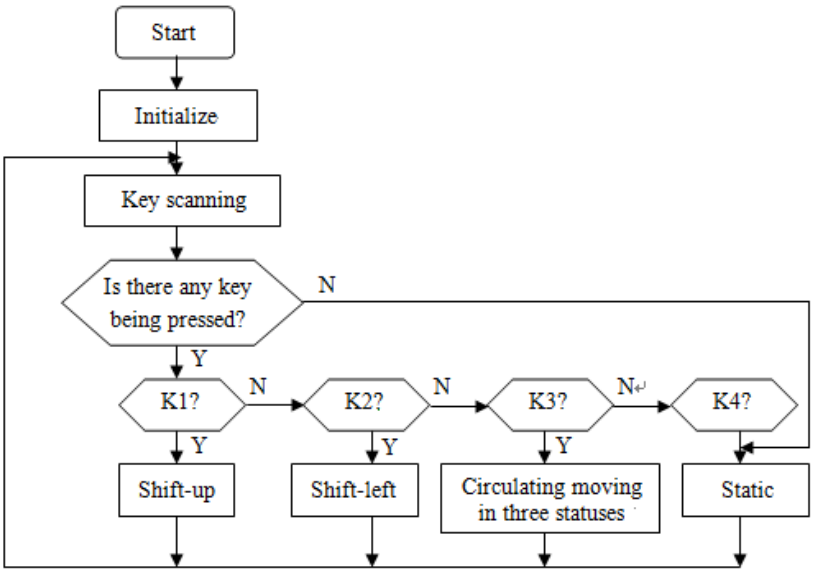

Fig. 5 System's main monitoring program flowchart

At first, the program initializes all macro definitions, global variables and data stored in ROM; then, it executes the key scanning program. If any key is pressed, the keystroke vibration elimination program will be executed first to minimize errors of the system. If "K1" key is pressed, content on LED display will shift up. If "K2" key is pressed, content displayed on LED display will shift left. If "K3" key is pressed, content on LED display will be displayed circularly among static display,

shift-left display and shift-up display. If "K4" key is pressed, it is the static display. Without any key pressed, the initial status is static display.

4.2 Design of key scanning program.

Key scanning program is mainly in the metaphase of program execution. With main functions continuously scanning the keyboard, if any key is pressed, the program will start to judge the key value and execute corresponding programs. When keys from K1 to K4 are pressed, values of global variable "a" is given 1 to 4 respectively; thus, when a specific key value is executed, changes in global variable is queried in real time; current display state can be interrupted and the state display for the key pressed can be executed. The flowchart of key scanning program is shown in Fig. 6.

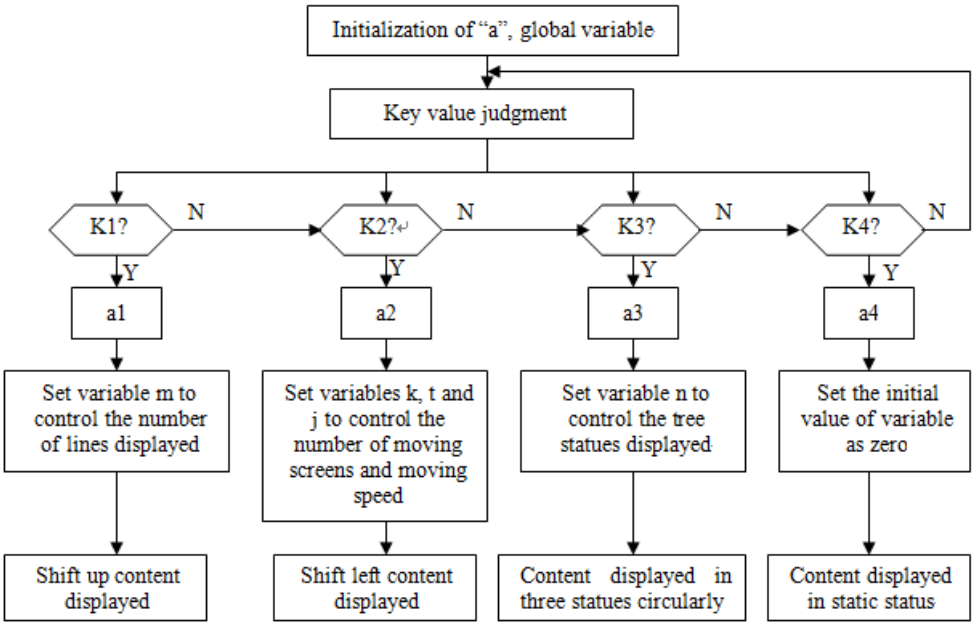

Fig. 6 Flowchart of key scanning program

5. Conclusion

The 8×8LED dot-matrix modules (32 modules in total) are used in the 64×32 LED dot-matrix display system designed this time. Although the circuit is simple, it covers the fundamental principles and basic programs of circuit of LED display; besides, graphs or words can be displayed in the static, shift-up, shift-left and circular display ways, so graphs and words displayed are stable and clear without any crosstalk. Meanwhile, the system also has the function of choosing contents to be displayed in the cache region by pressing keys.

References

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