Interface Design and Simulation of LCD1602 based on PROTEUS

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Abstract. In order to avoid defects in traditional teaching and design of the Single Chip Microcomputer, searching for new ideas about the SCM and embedded system development, in this paper, PROTEUS was used for SCM system design and simulation ’s platform, a hardware interface circuit has been designed between AT89C51 microcontroller and typical LCD1602, at the same time, the corresponding driver was designed in the Keil development environment, and completed the software and hardware co -simulation and debugging in PROTEUS system. This design process is simple, convenient and it has greatly improved the designing efficiency and reduced the designing cost. In addition, the circuit and driver played a certain reference role in the corresponding practical application system.

Keywords: PROTEUS; AT89C51; LCD1602; Interface Design; Simulation.

1. Foreword

As the multifunction EDA software launched by Labcenter Electronics, PROTEUS is the currently state-of-the-art embedded system teaching demonstration, design and smulation platform. PROTEUS has really realized intact design, R&D process at computer from the design of schematic diagram and circuit, circuit analysis and simulation, code debugging and simulation system test and function verification to intact design, R&D for PCB formation. Besides, in view of that all of the PROTEUS simulation models are established according to the technical parameters of corresponding components and parts, with the result that its emulation outcome is very near to practice. Therefore, it has transcended "virtual emulation" in ordinary significance and become the teaching, R&D platform with practical significance. It explains product R&D on the PROTEUS platform and emulation, as well as the basic method of the interface connecting 51 series SCM with LCD1602 through the interface design for the interface between AT89C51 SCM and LCD1602.

2. Design for AT89C51 and LCD1602 the hardware interface

LCD1602 is a typical LCD to display characters by means of 5×7 lattice diagram with 16 characters×2 lines (See Fig. 1). Standard 16-pin interface is generally accepted for LCD1602; for the condition of each pin, see Table 1.

Fig. 1 Typical character liquid crystal module real object diagram

LCD1602 internal structure is divided into three parts: Controller driver and display unit. Centralized controller is to be adopted generally as the controller; all-in-one type HD44780 that is specially used for character display control driving is to be adopted as the driver; HD44100 should be adopted as the driver for expanded display of character bits. LCD1602 control embodies mainly at the application of HD44780 instruction set. HD44780 is possessed of 11 instructions all together, with which display modes setup can be achieved, on/off and cursor setup can be displayed, as well as the

operations of data read-write, status read off etc. can be accomplished. By reason of the C language adopted for the programming in this design, therefore 8051 series simulation interface connection mode is adopted in this design. For the schematic diagram of interface circuit, refer to Fig. 2.

Table 1 LCD1602 module pins and functions

Pin#	Name	function	Pin#	Name	function
1	VSS	Power grounding	6	E	Empowering port
2	VDD	+5V power supply	7~14	D0~D7	8-bit two-way data line
3	VEE	LCD bias voltage signal	15	BLA	Back light anode
4	RS	Data/command selection port	16	BLK	Back light cathode
5	$R/\overline{W}$	R/W selection port			

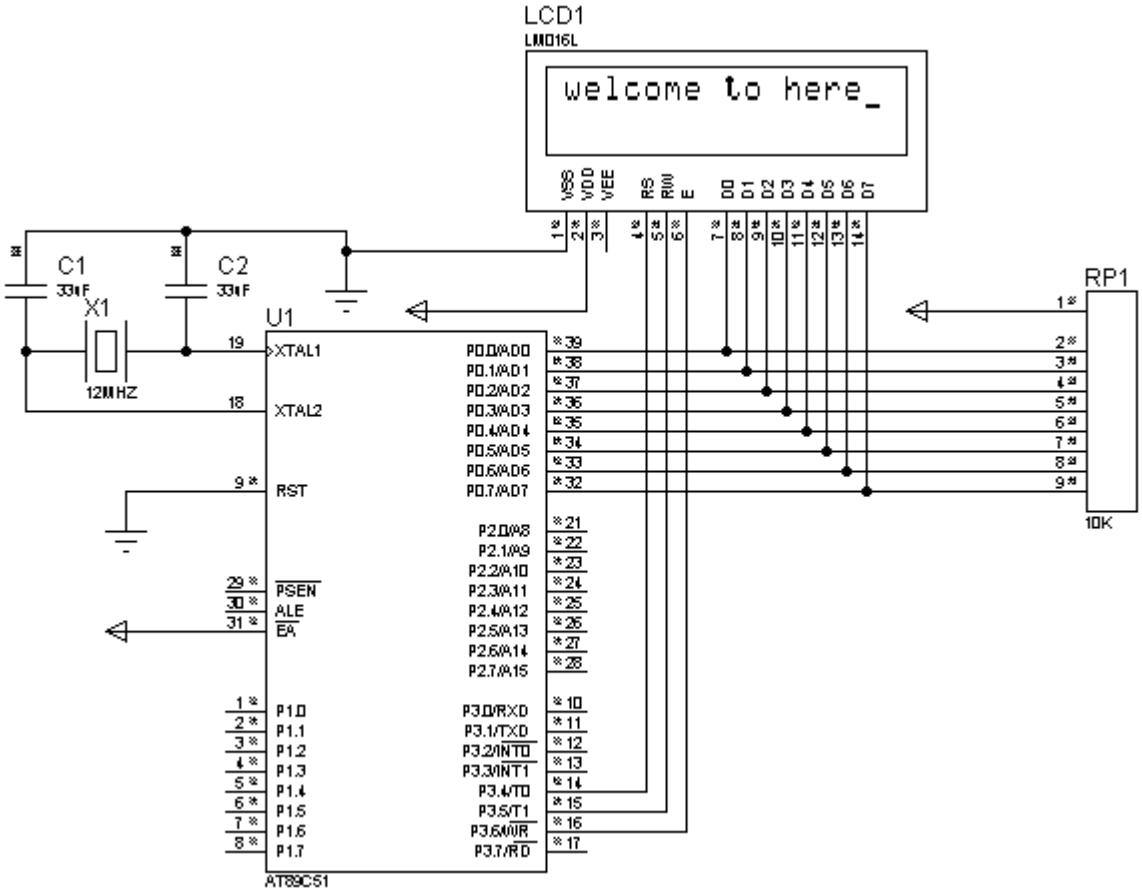

Fig. 2 Interface circuit schematic diagram for AT89C51 and LCD1602

Therein: The SCM is AT89C51 and LM016L is the 1602 type LCD model provided by PROTEUS. As a result of that LM016L has already provided self-contained interface with 51 series SCM, therefore, the only work to do is to connect D0~D7 with P0.0~P0.7 of AT89C51 in sequence; it'll be OK after; P3.4~P3.6 is connected with the pins RS, $R/\overline{W}$, E of the control LCD in sequence, among which the RP1 is resisters packs containing 8 resisters, and the pull-up resistors at each position could guarantee high level output from P0 port.

3. Software design

The program flow as that shown in Fig. 3 can be ascertained in accordance with the interface characteristics, instruction format, instruction function and interface time sequence of the controller HD44780. The corresponded C language driver list is as follows:

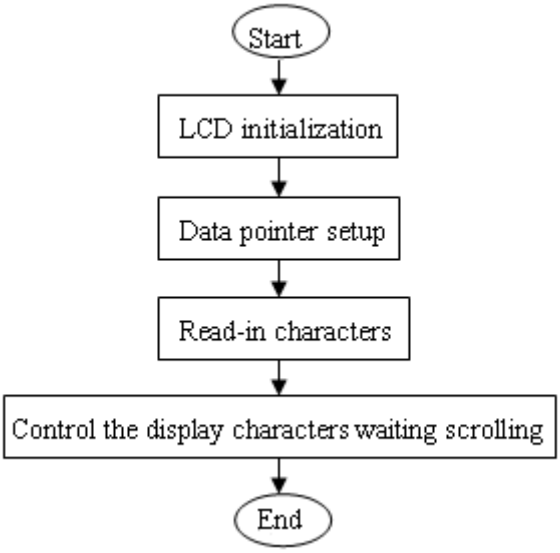

Fig. 3 LCD1602 driver flow diagram

```
#include<reg51.h>
#define uchar unsigned char
#define uint unsigned int
Uchar code table[]="welcome to here";
Sbit lcdrs=P3^4;
Sbit lcdrw=P3^5;
sbit lcden=P3^6;
uchar num;
Void delay (uint z) { //Time extension function
Unit x,y;
For (x=z;x>0;x--)
For (y=200;y>0;y--);}
Void write_com(uchar com) { //Write command function for LCD
P0=com;
Lcdrs =0;
Lcdrw =0;
Lcden =1;
Delay (5);
Lcden =0 ;}
Void write_data(uchar dat) { //Write data function for LCD
P0=dat;
Lcdrs =1;
Lcdrw =0;
Lcden =1;
Delay (5);
Lcden =0 ;}
void init() { //LCD initialization function
lcden =0;
write_com (0x38);
write_com (0x0e);
write_com (0x06);
write_com (0x01);
write_com (0x80) ;}
void main() {
init ();
```

```
for (num=0;num<15;num++) {
write data (table[num]);
delay (20); }}
```

4. System joint debugging

Open circuit emulation diagram and C engineering documents and start debugging in Keil "Debug →Start/Stop Debug Session", and operate "Debug →Go". By this time, Proteus emulation is started up by Keil and program running state could be observed in both Keil and Proteus. After said program starting running, LCD1602 display condition could be observed as that shown in Fig. 2. The source program in the Keil can also be compiled as.hex file and after that double click AT89C51 in Proteus to load corresponding. Hex file, and then start emulation process. Thus the LCD1602 display condition shown in Fig. 2 can also be observed.

5. Conclusion

Basing on Proteus circuit design, Keil program design and joint emulation debugging, the system could provide self-contained hardware design based on embedded system, software design, emulation debugging and virtual environment for effect emulation. It has resulted in evident improvement of design development efficiency, reduction of development risk. It's possessed of high auxiliary effect for both of the teaching demonstration of embedded system and practical design. All of the interface circuits and the practical application system corresponded to the driving program described in this article are provided with definite effect in use for reference.

The innovation points of the author of this article: Interface circuit between AT89C51 and LCD1602 is engineered in PROTEUS; corresponding driving program is engineered for the Keil; joint emulation debugging of both software and hardware PROTEUS is accomplished.

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