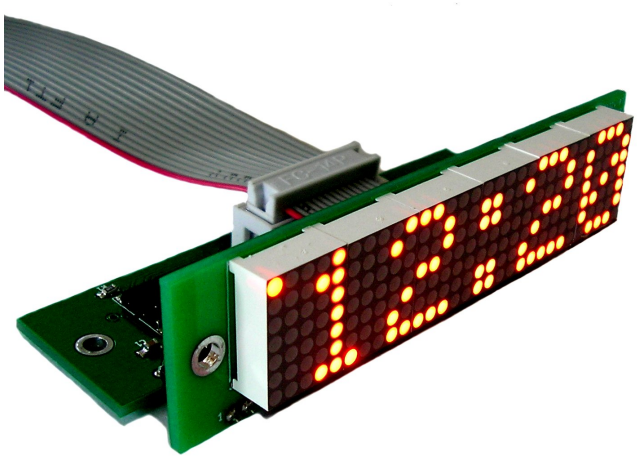
Multipurpose LED Display
(Open source hardware project)

Magictale Studio Developers



V 1.0-dev

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1. Preface

1.1 Project overview

The Multipurpose LED Display was designed as elegant and simple addition to microcontroller projects. In comparison with conventional LCD displays which have already overflooded the global market it has significantly bigger symbols brightly glowing in dark environments and distinctly visible from a distance of a few meters. At the same time, unlike 7-segment LED displays, this solution is capable of displaying not only digits but chain of characters. What it remarkable, the message length is not limited by the display width due to scrolling effect which is implemented in software. All these features will give your project new, unusual look and may make wider its application range. We will be very glad to know if you find this display really usful and meeting your own requirements.

Thank you and good luck,
Magictale Development team

2. Product Introduction

2.1 Specific features

The project has the following features:

- Six LED matrixes 5x7 dots, 36x7 dots in total driven by 9 signal lines (7x2 header includes GND and +5V power lines as well);
- Compact form factor, the assembly is split into two PCBs allowing to have vertical dimension virtually as low as the height of a LED matrix;
- LED panel itself comprises of LED matrixes and a connector only allowing to have interchangeable panels of different LED colors;
- Included sample AVR Assemlber source code contains definitions of first standard 127 symbols of ASCII table, subroutines for display refreshing, clearing, printing out a character/line, access on pixel level, smooth horisontal message scrolling. C-based sample code will be released soon as well;
- Easy to assemble, excellent kit for self education;
- Could be used in any AVR/PIC-based project for displaying alphabetical information or simple graphics and has a potential to give stylish and unusual look to your device;

3. Hardware Part

3.1 Circuit Diagram

The display is made up from six 5x7 dot matrix panels organised as common anode row, common cathode column and two low voltage constant sink LED drivers STP16CP05 IC1, IC2. LED current is defined by R1, R2 resistors. IC1 and IC2 are shift registers and allow to choose one column at a time, column data are fed through D0...D6. The display is refreshed by a software subroutine with a frequency of 1500Hz so all 30 columns are refreshed at 50Hz which make flickering unnoticed by a human eye. Please find the schematics on next page.

All components are available at Digikey supplier which makes it easier to order. The full list of parts is given below, each one has a Digikey number to simplify the search.

Table 3.1. Parts list

Position	**Manufacturer part number**	**Digikey part number**	**Comments**	**Qty**
IC1, IC2	STP16CP05MTR	497-5743-1-ND	IC LED Driver linear 24-SOIC	2
R1, R1	SMD resistor 680 Ohm 1/8W	P680ACT-ND		2
C1, C2	SMD ceramic capacitor 0.1 uF 50V	490-1666-1-ND		2
C3	SMD tantalum capacitor 250 uF 6.3V	718-1627-1-ND		1
JP1	Header 2x7, 0.100" pitch	HRP14H-ND	For connection with main unit	1
LM1 ... LM6	LED Matrix 5X7 0.7" Red-Orange	160-1553-5-ND	Common Anode Row, Common Cathode Column is prefferable but not compulsory	6
N/A	Header 13 pins, 0.100" pitch	S7011-ND	For two PCBs interconnection	2
N/A	Header 6x2 pins, 0.100" pitch	S7109-ND	For two PCBs interconnection	1
N/A	Header 36 pins, 0.100" pitch, right angle	609-2227-ND	For two PCBs interconnection	1
N/A	Header 6x2 pins, 0.100" pitch, right angle	609-3345-ND	For two PCBs interconnection	1

The circuit diagram is done by means of gEDA tool, please see below:

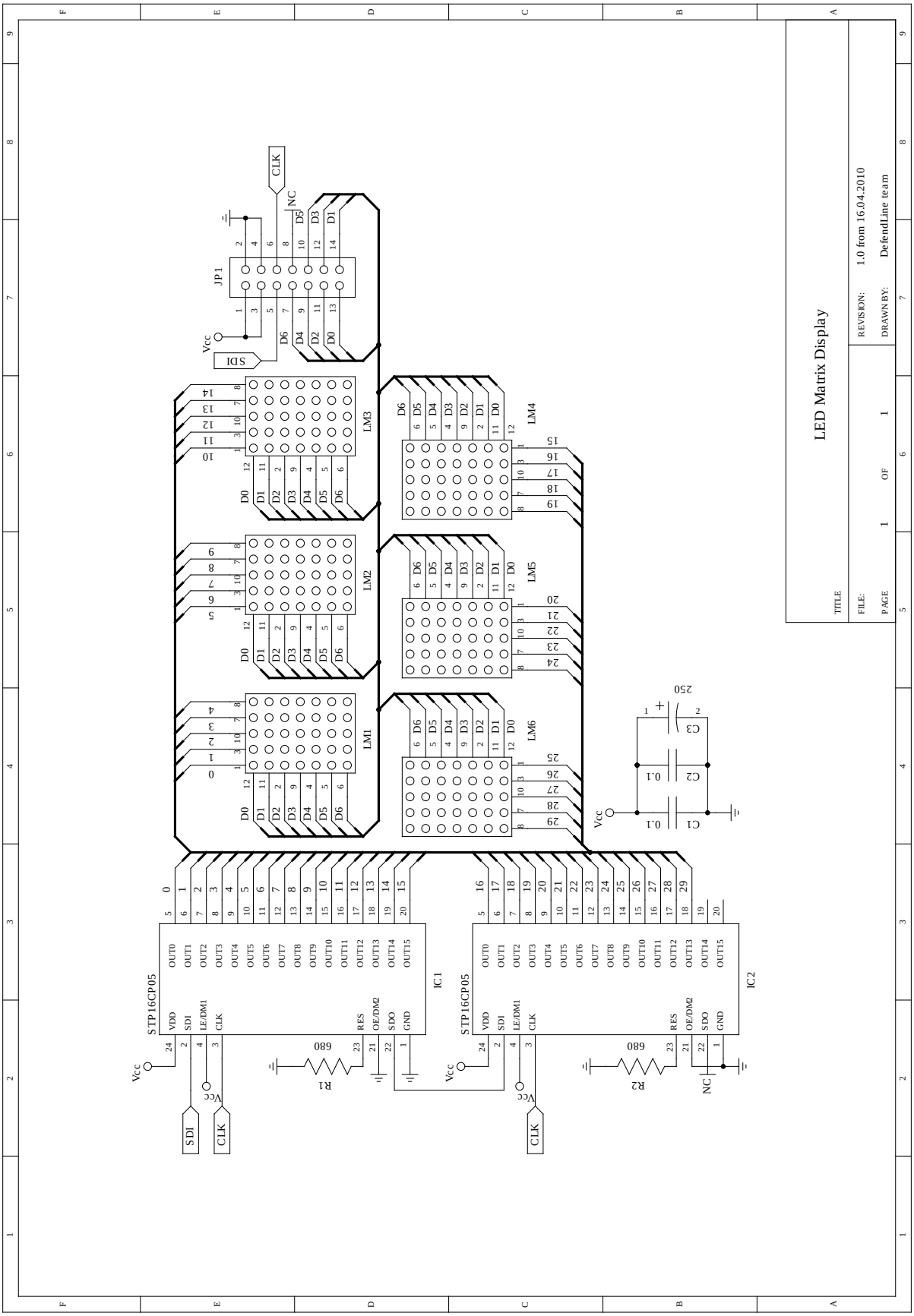

Figure 3.1. LED Display Circuit Diagram

Interfacing with microcontroller is available through 14-pin header. Overall, 9 data pins are required from microcontroller side, the rest pins are given to GND and power supply lines, please see below:

Table 3.2. Connector pinout

Pin number	Description	Comments	Pin number	Description	Comments
1,3	VCC, +5V		2,4	GND	
13	Row 0		14	Row 1	
11	Row 2		12	Row 3	
9	Row 4		10	Row 5	
7	Row 6		8	Row 7	Not used
6	CLK, Serial clock		5	SDI, Serial Data Input	

3.2 PCB And Component Layout

PCB component layout is given below. As you may notice, all components are placed on one side of the board.

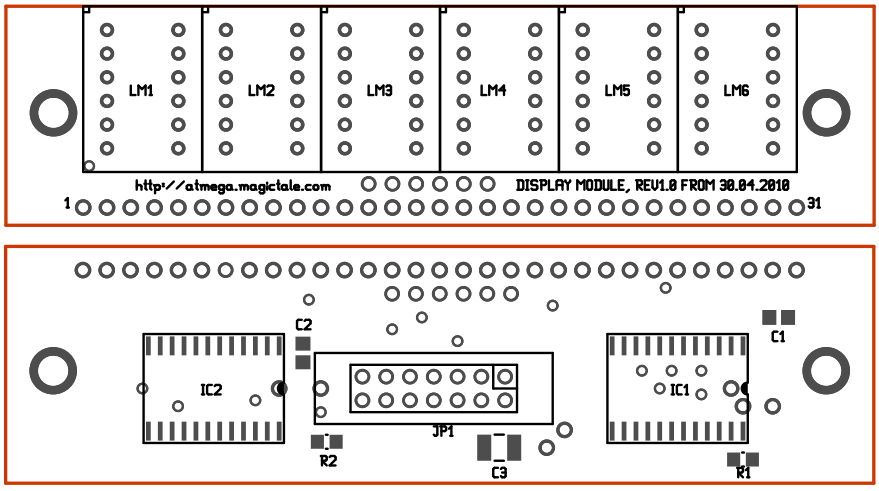

Figure 3.2. LED Display PCB Layout

Both PBCs, ready for assembling, are given below:

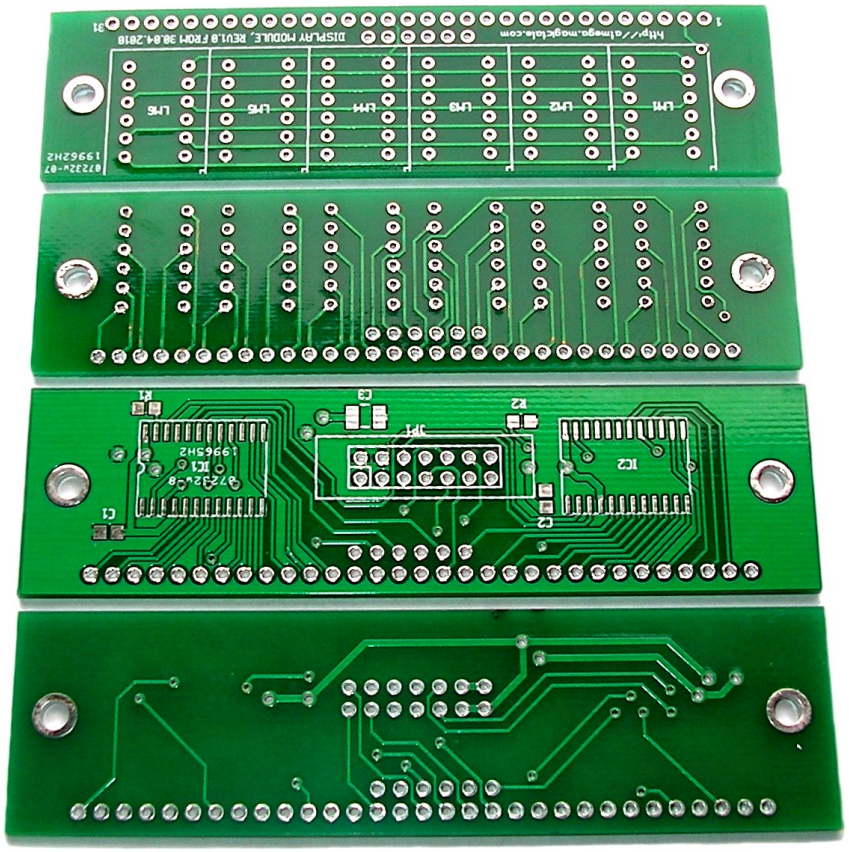

Figure 3.3. PCBs ready for assembling

3.3 Assembling

Let's get ready for the assembling procedure. We will need a solder iron with temperature control/soldering station with a conical tip thin enough to solder 1.25 mm pitch pins, solder itself, solder wick, a multimeter, flush/diagonal cutters, a magnifying glass, a needle file and an utility knife. It is vital to have enough of light (prefferable daylight) as most of the components are reasonably small.

Despite the usual recommendations to solder microchips last it is more convenient to start with IC1 and IC2 LED drivers as they have small sizes and multiple leads so we will need more space and freedom for manipulations. Position a chip properly and fix it by soldering two dialonally located outer leads. Carefully check if all leads are located on their pads without overlapping them. If everything is fine solder the rest of the leads. Do not overuse solder as it will lead to shortcuts between the leads. If it happened, remove excess of the solder with help of solder wick then continue soldering again. Watch out for the time, do not heat the same place too long, it is harful for both chip and pads. When the chip is done, have it examined visually, maybe even with help of magnifying glass. Repeat the same steps for the second chip.

Solder R1, R2 resistors and C1, C2, C3 capacitors. Be aware of C3 polarity, do not confuse its positive and negative leads. Then solder JP1 connector, make sure it is on the same PCB side as the rest components and it has correct orientation.

Time to solder the interboard connector. It comprises of a three parts on each PCB. Start with the PCB carrying LED panel and central S7109-ND two-row header. Solder it. Them whith help of knife and neddle file fit two S7011-ND one-row headers (remove one pin for one header, it should have 12 pins). Do not solder all pins this time, just the outer ones, it will contribute to the final adjacements before soldering.

Cut 12 and 13 pins from 609-2227-ND header and try on if they fit with 609-3345-ND together. If not, work with the knife/needle file a little. Connect S7109-ND and 609-3345-ND, elements from 609-2227-ND with S7011-ND then fit them to the PCB with chips and solder a few pins trying to make 90 degree angle between two board. Check the results again before soldering of the rest pins.

Find first LED matrix pin. The problem is that some manufacturers do not mark first pins. Use multimeter to make sure that you are not mistaking. Solder LED matrixes keeping is mind their correct orientation. The display is almost done.

Inspect both PCBs carefully trying to find problem soldering spots and potential short circuits and get rid of them if you found anything. Your asselmbly should look like this:

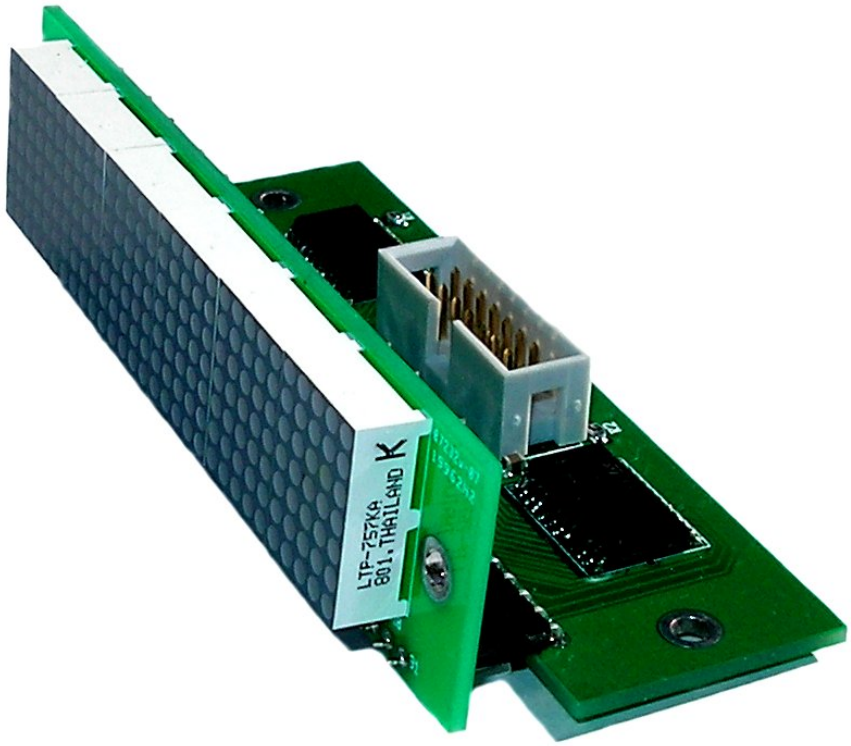

Figure 3.4. Assembled LED Display PCB

4. Software Part

4.1 Software overview

The display is natively supported by DefendLine Project. The project has opensource code written in AVR assembler (specificaly, for ATMega16/32 chips) so that code could be easily re-used with your own projects with minimal modifications. The original source code could be found at: Source Forge site.

More information about display software support and especially C-based library will be released soon. Stay tuned...

5. References

- *DefendLine project*, `http://atmega.magictale.com/?page_id=4`
- *5x3 LED CUBE Controller* for PIC16F688, `http://picprojects.org.uk/projects/lc/index.htm`
- *Atmel*, AVR microprocessrors manufacturer, `http://www.atmel.com/`
- *MagicTale AVR projects*, Magictale community home, initiator of this project, `http://atmega.magictale.com`