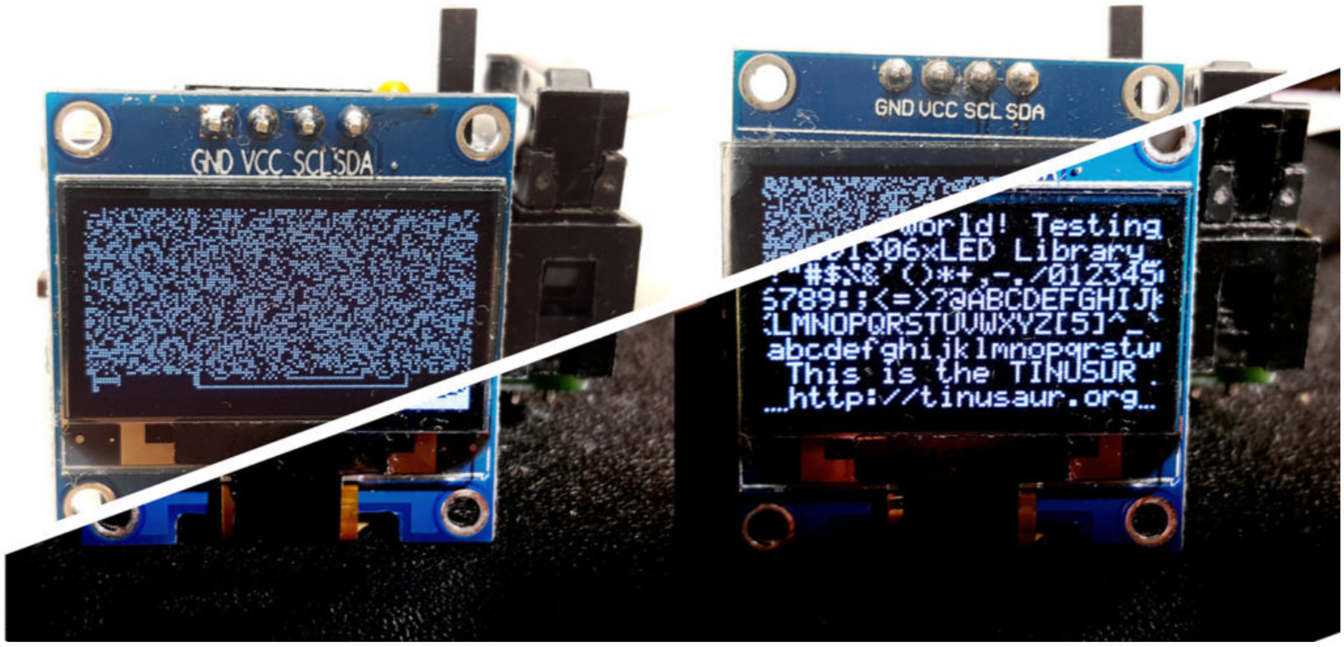
MENU

SSD1306

UPDATED SSD1306XLED LIBRARY, FIXES, COMPATIBILITY WITH SSD1315 AND MORE

Posted on **2019-04-29** by **neven**

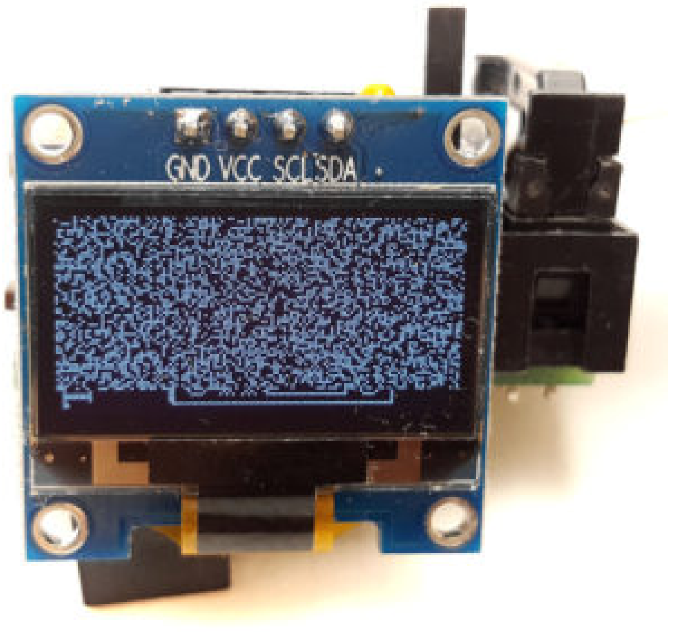


Our **SSD1306xLED library** works well with the **SSD1306** displays, it is small as binary code and is very fast.

But, there was a problem …

Several months ago we ordered some displays from the Far East and we expected them to work just fine. Unfortunately, they did not. And the problem was not in our library but with the chips. Instead of SSD1306, it seems they put the not that well known **SSD1315** OLED display controller. We found that out by looking closely at the PCB, beneath the LCD glass plate.

The testing script was producing the result shown in the picture. Note the bottom lines – they were not redrawn, or not always, at least.

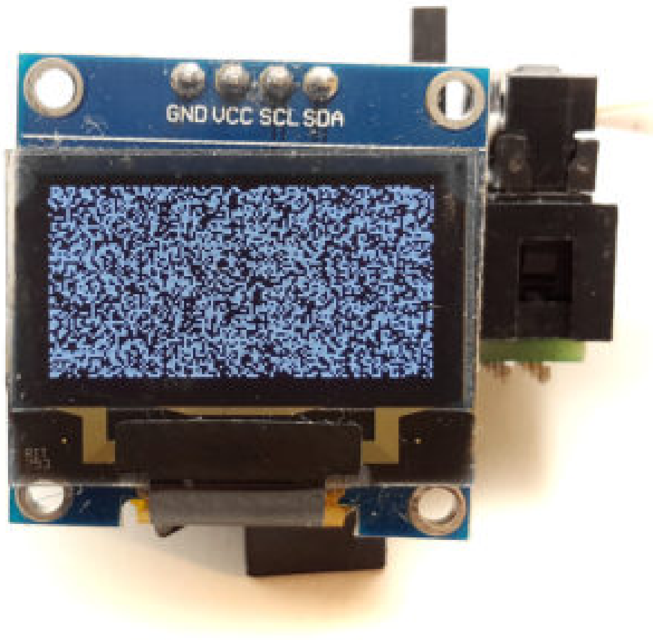


SSD1315 OLED display controller

On another display that we've got earlier, a few years ago, and that was using the SSD1306 controller the picture was looking good.

Apparently, the problem was with the display controller. Further experiments proved that.

What made it worse for us was that we've discovered that from about a hundred display modules we've ordered recently half seemed not compatible with our code. We couldn't even figure out what exactly was the OLED controller on those modules – SSD1306 as stated in the description where we bought them, or the SSD1315 looking at the testing scripts results. So, we decided to just fix the problem for both kinds of chips. Easy to say it than to do it.



SSD1306 OLED display controller

First attempt

2 months ago. We played with the timing and the speed of the data sent to the modules. Tried a few other things, like reordering the commands sent while drawing. We even

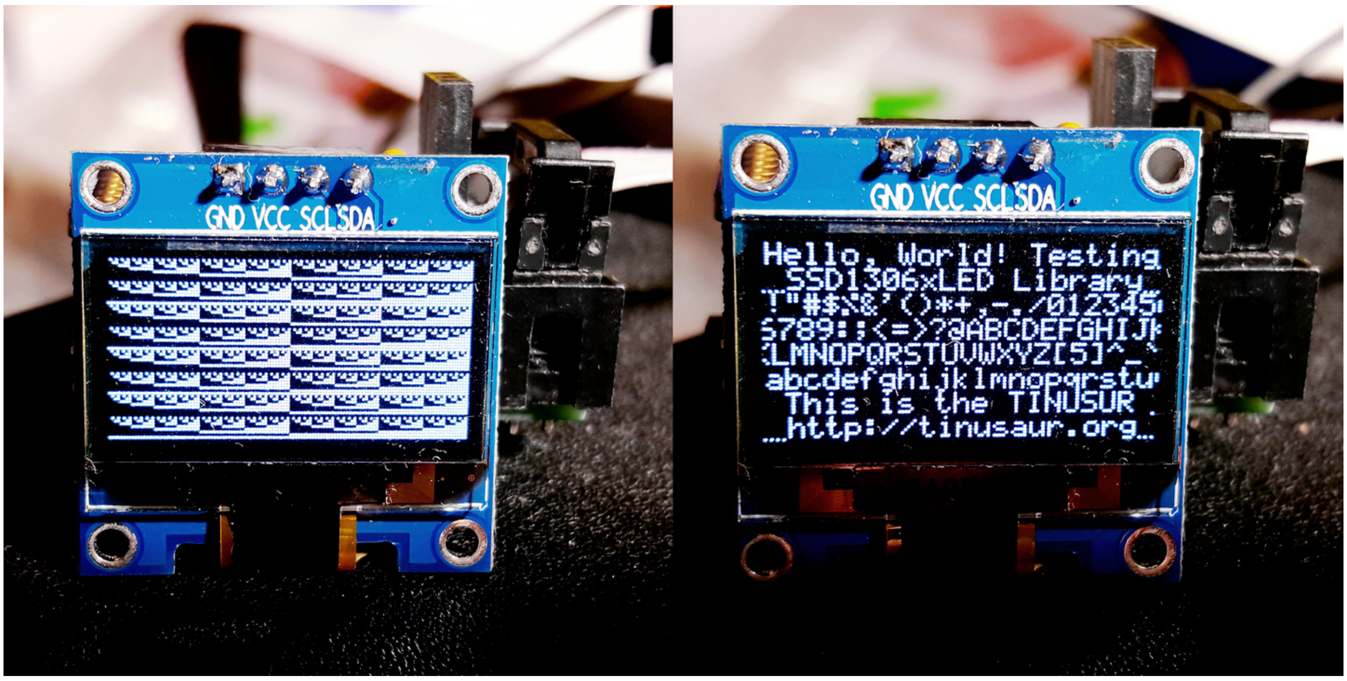
moved some of the I2C specific code to a separate library to isolate the potential problems and try to fix the issue. No luck.

Second attempt

2 days ago. We decided to re-do the initialization sequence for the OLED controller. These are the commands that we send to the chip before we start drawing things on the display. We read, again, the Solomon Systech PDF file about the SSD1306 controller – the so-called datasheet. There was a half-baked algorithm of how to initialize the chip. Also, looked at several other libraries to see how they do it. Actually, the “Adafruit_SSD1306.cpp” was a really good example so we used some know-how from it.

Wrote the code. Tested it. And, it worked!

Done!



SSD1306xLED Testing

Some optimizations

There were a couple of TO-DO’s in the source code for the optimization of multiplication by a constant. That could be easily converted to a combination of 1 or more left-bitwise-shift and additions.

```
void ssd1306tx_char(char ch) {
  uint8_t c = ch - 32; // Convert ASCII code to font data index.
  ssd1306_start_data();
  for (uint8_t i = 0; i < 6; i++) {
    ssd1306_data_byte(pgm_read_byte(&ssd1306tx_font_src[c * 6 + i]));
  }
  ssd1306_stop();
}
```

We combined the **c = ch – 32** and the **c * 6 + i** and optimized the entire expression.

```
void ssd1306tx_char(char ch) {
  uint16_t j = (ch << 2) + (ch << 1) - 192;
  ssd1306_start_data();
  for (uint8_t i = 0; i < 6; i++) {
    ssd1306_data_byte(pgm_read_byte(&ssd1306tx_font_src[j + i]));
  }
  ssd1306_stop();
}
```

That saved us about 30 bytes of binary code and it is probably a bit faster than the multiplication with a subroutine.

We did something similar for the **void ssd1306tx_stringxy(const uint8_t *fron_src, uint8_t x, uint8_t y, const char s[]);** function but without the left-bitwise-shift as the compiler optimizes the very well the multiplication with numbers that are powers of 2, i.e. 2, 4, 8, etc. In our case – 16. That saved us another 20 bytes of binary code and probably gained some speed.

So, we saved about **50 bytes** of machine code and gained some speed. That might not look that much but for a microcontroller with **4096 bytes for code** and 1 or 8 MHz CPU that's about **1.2% less memory** usage. And, our library is now a bit faster.

Resources

There are more functions in the **SSD1306xLED** library such as for printing text and numbers on the screen and drawing images but that will be subject of another article.

The official page of the library (will be):
/software/libraries/ssd1306xled/

Source code is available at:
https://bitbucket.org/tinusaur/ssd1306xled/src

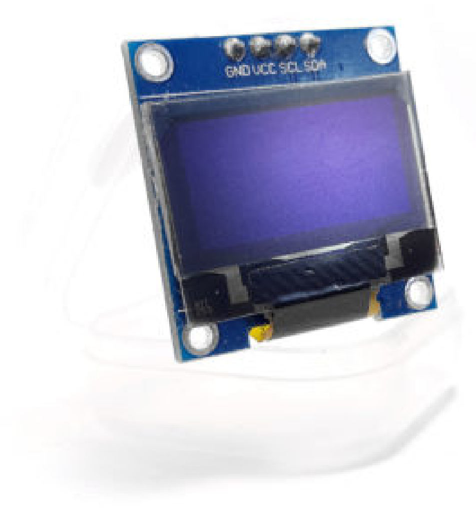
Posted in **Libraries** Tagged **attiny85**, **library**, **oled display**, **SSD1306**, **SSD1306xLED**, **SSD1315**, **tinusaur** **1 Comment**

C LIBRARY FOR SSD1306 OLED DISPLAY AND ATTINY85

Posted on **2019-02-10** by **neven**

It isn't hard to get one of those **OLED** displays from eBay or another place. They are usually controlled by **SSD1306** chip – one of the most popular. Such displays could be used for a number of things – from just learning to control them and showing some text/numbers/graphics, display sensors' data or even creating a small game.

Back in 2014, we wrote a small library for the **ATtiny85** microcontroller to work with such displays and we called it **SSD1306xLED** after the name of the controlling chip for the display.



Here is a link to check what's for sale now: **http://www.ebay.com / OLED 128 64**

SSD1306 OLED Display

IMPORTANT DISCLAIMERS:

1. This library works with the display modules that use the **I2C** protocol. This is important to know since there are other similar displays that use the same **SSD1306** controller but communicate over the **SPI** interface. In that case, our library will not work. We use, in most cases, the modules with 4 pins – **GND**, **Vcc**, **SCL**, **SDA**.
2. Although using the **I2C** interface, our **SSD1306xLED** library does not implement the **I2C** protocol but just a subset of it enough to accomplish the task of sending commands and data to the display. This comes with 2 great advantages: (1) it is super fast; (2) is super small – more details about those characteristics will be outlined below.

The library is, of course, **open source** and all the software is available at https://bitbucket.org/tinusaur/ssd1306xled/

The I2CSW sub-library

This is a small sub-library that implements a subset of the **I2C** protocols that is necessary to send some commands and data out. **I2CSW** stands for "**I2C Simple Writer**" and as its name implies it only writes out.

There are 2 macros to sent the **SCL** and **SDA** wires to high and to low, or, or 1 and 0.
— **I2CSW_HIGH**(PORT)
— **I2CSW_LOW**(PORT)

Then, there are 3 low-level functions:
— void **i2csw_start**(void);
— void **i2csw_stop**(void);
— void **i2csw_byte**(uint8_t byte);

The **i2csw_start** function sets the SCL and SDA pins as output and the "start" condition. In other words, it lets the devices connected to the microcontroller know that we are about to send something out.

The **i2csw_stop** function sets the "stop" condition. This indicates that we have finished with sending the data. It also set the SDA pin as input so it won't keep the SDA line at HIGH all the time.

SSD1306 I2C Start and Stop Condition

The **i2csw_byte** function sends one byte of data out. It is used to send commands and data to the I2C devices – the display in our case.

SSD1306 I2C Acknowledgment Condition

NOTE: The I2CSW library does not handle the acknowledgment condition.

The ssd1306 core functions

There are 4 core functions in the library at the moment:
— void **ssd1306_start_command**(void);
— void **ssd1306_start_data**(void);
— void **ssd1306_data_byte**(uint8_t);
— void **ssd1306_stop**(void);

The **ssd1306_start_command** function indicates to the connected I2C devices that we're about to send commands. This is used to configure the controller o to set some parameters such as the current position on the display.

The **ssd1306_start_data** function indicates to the connected I2C devices that we're about to send some data. This is used to send some data to the display controller – like bitmaps or text.

The **ssd1306_data_byte** function sends 2 bytes of data to the display controller. That is used for both commands and data.

The **ssd1306_stop** function indicates that we have finished transmitting data.

SSD1306 I2C Write data

The ssd1306 supplementary functions

These are convenience functions:
— void **ssd1306_init**(void);
— void **ssd1306_setpos**(uint8_t x, uint8_t y);
— void **ssd1306_fill4**(uint8_t, uint8_t, uint8_t, uint8_t);

The **ssd1306_init** function sends a sequence of commands that will initialize the display controller so it will work the way we expect.

The **ssd1306_setpos** function sets the current position on the display. Sending data after this command will display it at that position.

From the documentation:

> **Horizontal addressing mode (A[1:0]=00b)**
> In horizontal addressing mode, after the display RAM is read/written, the column address pointer is increased automatically by 1. If the column address pointer reaches column end address, the column address pointer is reset to column start address and page address pointer is increased by 1. The sequence of movement of the page and column address point for horizontal addressing mode is shown in Figure 10-3. When both column and page address pointers reach the end address, the pointers are reset to column start address and page start address (Dotted line in Figure 10-3.)
> *Solomon Systech Apr 2008 P 42/59 Rev 1.1 SSD1306*

SSD1306 I2C Horizontal addressing mode

The **ssd1306_fill4** function fills out the screen with the 4 bytes specified as parameters. The reason for 4 bytes is that it is convenient for filling out with patterns.

There are 3 other functions derived from the ssd1306_fill4 function:
— **ssd1306_clear**() – clears the screen, i.e. fills it out with "0".
— **ssd1306_fill**(p) – fills the display with the specified byte.
— **ssd1306_fill2**(p1, p2) – fills the display with the 2 specified bytes.

The testing scripts demonstrate the purpose and usage of those functions.

The testing in the "ssd1306xled_test1" folder

Source code at
https://bitbucket.org/tinusaur/ssd1306xled/src/default/ssd1306xled_test1/main.c

This testing script demonstrates the use of the functions in the library.

The first section fills out the screen with **random** values using a Linear congruential generator.

SSD1306 Library SSD1306xLED Testing Script

The second section fills out the screen with a sequential number that creates some patterns on the screen.

SSD1306 Library SSD1306xLED Testing Script

The next section fills out the screen line by line.

SSD1306 Library SSD1306xLED Testing Script

The last section fills out the screen with various patterns.

SSD1306 Library SSD1306xLED Testing Script SSD1306 Library SSD1306xLED Testing Script

SSD1306 Library SSD1306xLED Testing Script

SSD1306 Library SSD1306xLED Testing Script

SSD1306 Library SSD1306xLED Testing Script

SSD1306 Library SSD1306xLED Testing Script

More functions …

There are more functions in the **SSD1306xLED** library such as for printing text and numbers on the screen and drawing images but that will be subject of another article.

Please, share your thoughts!

Posted in **Libraries** Tagged **attiny85**, **Display**, **OLED**, **SSD1306**, **SSD1306xLED**, **tinusaur** **3 Comments**

LAUNCHED CROWDFUNDING CAMPAIGN FOR THE TINUSAUR OLED DISPLAY KIT

Posted on **2019-01-21** by **neven**

We have just launched our crowdfunding campaign at **Crowd Supply** for the **Tinusaur OLED Display Kit** – a bundle of boards and modules that allows you to connect an **ATtiny85** microcontroller to an **SSD1306 OLED display**. This is a kit so you have to assemble the boards yourself by soldering the parts to the PCB thus start learning about electronics and physics. It might sound complicated at first but these **Tinusaur boards** are very easy to assemble using the **guides** and tutorials that we provide. Once all the boards are assembled you could connect a **DHT11** sensor module, measure temperature and humidity and show the results on the screen.

Tinusaur OLED Display Kit

With the **Tinusaur OLED Display Kit**, you get everything you need to start: the Tinusaur main board with the ATtiny85 microcontroller, the LED shield for test and learning, the OLED display shield, the SSD1306 OLED display, the DHT11 sensor module, a LiPo battery kit, and, a USBasp programmer.

The Tinusaur is an Open Source project – both the software and the hardware. Our own library for with the display, called **SSD1306xLED**, is considered one of the fastest for that display and microcontroller.

Check out the **campaign page** for details!

Posted in **Announcements** Tagged **crowd supply**, **crowdfunding**, **oled display**, **SSD1306**, **tinusaur** **Leave a comment**

CROWDFUNDING CAMPAIGN FOR THE TINUSAUR OLED KIT

Posted on **2019-01-18** by **neven**

We are launching #CROWDFUNDING campaign at @CROWD_SUPPLY – next week! It will be for the #Tinusaur OLED Kit – the display shield that many of our users have asked for. Subscribe for the launch updates or just wait until it starts. 😉
https://www.crowdsupply.com/tinusaur/oled-display-kit

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LAUNCHING CROWDFUNDING CAMPAIGN IN JANUARY

Posted on **2018-12-28** by **neven**

It looks like that our most popular software library is the **SSD1306xLED**. This is a library for working with **OLED displays** based on the **SSD1306** controller. So, we decided to create a Tinusaur shield to carry an OLED display and we're thinking about putting it up for **crowdfunding** this January.

What could you do it a Tinusaur Board and an OLED display?

There is an internal temperature sensor built into the **ATtiny85** microcontroller and you don't need any external components to use it. You can read its value and show it on the display.

Tinusaur OLED SSD1306xLED measuring temperature and voltage

We’ve figured a way to measure the battery level (or the power supply voltage) connected to the ATtiny85 microcontroller by using the PB5 (that is the RESET pin, yes) and one additional resistor. It is not very precise but could give you an indication, at least.

DHT11 Module

You could also connect one of those popular **DHT11** sensor modules, measure temperature and humidity and show it on the screen.

You could also connect the **Bosch BMP180** sensor module and measure barometric pressure and temperature, and show it on the screen. That will also allow you to calculate the altitude – pretty neat, isn’t it?

BM180 Module

The official announcement with information about the start date, goals and other details is coming up in early January.

Posted in **Announcements** Tagged **attiny85**, **BMP180**, **campaign**, **crowdfunding**, **DHT11**, **SSD1306**, **tinusaur** **Leave a comment**

PRINTING DECIMAL NUMBERS ON SSD1306 OLED DISPLAY USING THE SSD1306XLED LIBRARY

Posted on **2015-01-20** by **neven**

UPDATE: Please, check the most recent post about this library at **/tag/ssd1306xled**

After playing for awhile with that **SSD1306 OLED** display I decided to add few more things to the **SSD1306xLED** library and the ability to print numbers seamed to be an important one.

There is already a function in the library that outputs strings so I needed only the conversion from **int** to a decimal **string.** So I used another function **usint2decascii** that I previously wrote for another project **OWOWOD** which code, in turn, I borrowed from a third project **LCDDDD** – an **LCD D**irect **D**rawing **D**river for **PCD8544** based displays such as **Nokia 3310 LCD**. The weird LCDDDD name comes from the fact that it outputs the data directly to the LCD instead of storing it into a buffer first and then periodically outputting it to the LCD – this is unlike most of the popular LCD drivers.

Here is the main function definition …

```
    uint8_t usint2decascii(uint16
```

The function requires a small **buffer** to store the result. Since the largest number is **65535** – that is 0xFFFF in hex, 5+1 bytes are needed for that buffer.

For convenience, there are 2 functions for direct printing of numbers. Below is their implementation – it's very simple:

```
#define USINT2DECASCII_MAX_DIGITS 5

char ssd1306_numdec_buffer[USINT2DECASCII_MAX_DIGITS + 1];

void ssd1306_numdec_font6x8(uint16_t num) {
  ssd1306_numdec_buffer[USINT2DECASCII_MAX_DIGITS] = '&#092;&#048;';
  uint8_t digits = usint2decascii(num, ssd1306_numdec_buffer);
  ssd1306_string_font6x8(ssd1306_numdec_buffer + digits);
}

void ssd1306_numdecp_font6x8(uint16_t num) {
  ssd1306_numdec_buffer[USINT2DECASCII_MAX_DIGITS] = '&#092;&#048;';
  usint2decascii(num, ssd1306_numdec_buffer);
  ssd1306_string_font6x8(ssd1306_numdec_buffer);
}
```

The **ssd1306_numdec_font6x8** only prints the number while **ssd1306_numdecp_font6x8** prints numbers the same way but right-aligned and 5-digit padded.

Printing numbers is as simple as this …

```
    ssd1306_setpos(20, 4);
    ssd1306_numdecp_font6x8(12345);
```

Here is a little more complicated example …

```
    ssd1306_setpos(40, 3);
    ssd1306_string_font6x8("a=");
    ssd1306_numdecp_font6x8(0xFA32); // dec: 64050
    ssd1306_setpos(40, 4);
    ssd1306_string_font6x8("b=");
    ssd1306_numdecp_font6x8(0x05CD); // dec: 1485
```

It prints “a=”, “b=” and then their values. Both numbers are right-aligned and left-padded with up to 4 spaces.

The latest test program in SSD1306xLED includes examples of how to use the **ssd1306_numdec_font6x8** and the **ssd1306_numdecp_font6x8** functions.

The SSD1306xLED library is at **SSD1306xLED page**.

The source code of the SSD1306xLED is available at **https://bitbucket.org/tinusaur/ssd1306xled**

The source code of the TinyAVRLib is available at **https://bitbucket.org/tinusaur/tinyavrlib**

Posted in **Libraries** Tagged **atmel**, **attiny**, **attiny85**, **driver**, **library**, **microcontroller**, **OLED**, **SSD1306**, **SSD1306xLED**, **tinusaur** **3 Comments**

C LIBRARY FOR ATTINY85 TO WORK WITH SSD1306 CONTROLLED OLED DISPLAY

Posted on **2014-08-29** by **neven**

UPDATE: Please check the most recent post about this library at **/tag/ssd1306xled**

I recently bought an **OLED display** 128×64 from eBay (**http://www.ebay.com/sch/i.html?_nkw=OLED+128**) – very inexpensive (about 4 euro) but when I finally received it I was surprised to see how small it was – I was expecting something that looked more like the **Nokia 3310 LCD**. So I thought – this is perfect for the **Tinusaur Project**. The 128×64 OLED is controlled by an **SSD1306** circuit and could be interfaced over **I²C**. The first challenge that I faced was that all existing libraries that I found were for **Arduino** boards … and I wrote my own based, of course, on existing code – the **SSD1306xLED library**.

SSD1306xLED is a C library for working with the **SSD1306 display driver** to control dot matrix OLED/PLED 128×64 displays. It is intended to be used with the Tinusaur board but should also work with any other board based on **ATtiny85** or similar microcontroller – ATtiny45/ATtiny25, even ATtiny13.

The code could be divided into 3 pieces: (1) communication over I²C with the SSD1306; (2) sending graphical commands to the display; (3) high-level functions such as printing characters.

The I²C communication part is based on modified **IIC_wtihout_ACK** library that is available on the Internet but its original website (**http://www.14blog.com/archives/1358**) is no longer functional. Basically, it made it work on ATtiny85 and Tinusaur.

The SSD1306xLED library still needs work and improvements.

The main location for the library is **SSD1306xLED page**.

The source code along with very simple example is available on Bitbucket at this address: **https://bitbucket.org/tinusaur/ssd1306xled**

Posted in **Libraries** Tagged **attiny13**, **attiny25**, **attiny45**, **attiny85**, **Display**, **display driver**, **OLED**, **SSD1306**, **SSD1306xLED**, **tinusaur** **7 Comments**

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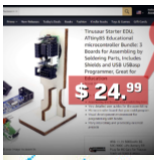

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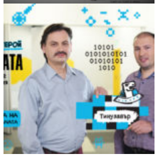

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