

# INTERFACE FOR READING DATA FROM 1D CMOS SENSOR HAMAMATSU S10077 WITH BUILT-IN A/D CONVERTER

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This paper presents a way for practical use of the CMOS linear image sensor S10077 from Hamamatsu with built-in A/D converter. Communication with the device is realized by the USB interface.

## 1 Introduction

The measurement of luminance is a critical problem, especially in cooperation with a computer system. The main part of the circuit is a suitable sensor, which is able to generate a signal adequate to the luminance. In a digital processing we need to convert the signal from an analog to a digital one and to send it to PC through some compatible interface. The whole device can be build as PCB card, which is embedded into the PC. (for example Eureka Messtechnik GmbH Köln, Germany) [1]. In our case (fig. 1), we have built an interface for sensor CMOS S10077 (Hamamatsu), which communicates with PC through USB, so no other accessory is required. This project is an innovation of our previous works [2] and [3].



Fig. 1 Block diagram of device.

## 2 Selection of parts

As a sensor we use Hamamatsu S10077, which is 1D line CMOS sensor with a built-in amplifier and A/D converter (fig.2).



Fig. 2 Linear line image CMOS sensor Hamamatsu S10077.

Data from this circuit are exported by digital bus SPI (Serial Peripheral Interface). The sensor acts as Master on the SPI bus. When start pulse on pin 23 is received, the sensor is scanning a line and send it by SPI to the connected device.

Because standard personal computers (PC) do not have SPI ports it is necessary to use a converter, which is able to read data by SPI and subsequently send this data to PC via standard serial

line RS232 or USB. The converter should contain SPI interface which is able to work in Slave mode, asynchronous serial port compatible with PC (RS232) and has at least 2048kB of RAM memory for the measured data. Because of these requirements the microcontroller ATMEGA644PA has been chosen. As a lot of new PCs do not contain serial ports RS232, but only USB ports, we use the circuit UM232R from FTDI to convert RS232 to USB.

## 3 Mechanical construction

The device is built on a single side PCB board (fig. 3 and realization of the camera is in fig. 4) to which the three sockets are soldered.

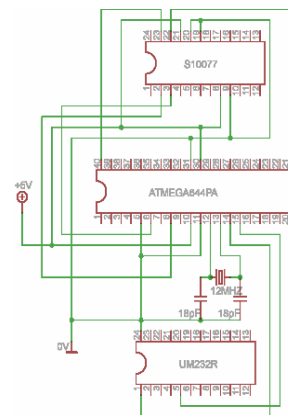


Fig. 3 Scheme of CMOS sensor S10077.

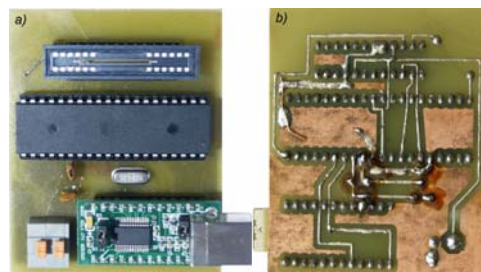


Fig. 4 Realization of camera (a) Front view, b) Bottom view.

In the upper socket there is Hamamatsu S10077 sensor, in a middle one there is ATMEGA 644PA

microcontroller and in a bottom socket there is the FTDI UM232R module.

The device also contains the timing crystal 12MHz, two capacitors 12pF for proper function of timing oscillator and a terminal block for power +5V. For prevention of disturbance from PC there is not used power voltage from USB, but from an external source which allows good smoothing.

#### 4 Program for the microcontroller

The program for the microcontroller ATMEGA 644PA was written in C in CodeVisionAVR. The algorithm is waiting for any mark sented from PC. After receiving this mark which serves as a start signal, the program sends the start signal from port C.0 to the sensor for a line scan. At the same time the register of a microcontroller is cleared and prepared for filling by values. After that algorithm (with using SPI function) reads data from SPI to register. At the last time it sends this data from register to UART and thought module UM232R via USB to PC.

DEFINITION OF VARIABLES:  
 unsigned char x[1024];  
 unsigned char z;  
 unsigned int i;  
 unsigned char spi(unsigned char data);

```

MAIN PROGRAM CODE:
while (1)
{
  z=getchar(); //WAITING FOR ANY CHAR FROM SERIAL LINE
  i=0;
  PORTC=0x00; //IMAGE EXPOSAL
  delay_ms(1);
  PORTC=0x01;

  for (i = 0; i < 1023; i++) //CLEARING VARIABLE I
  {x[i]=0;}

  delay_ms(1);
  PORTC=0x00;

  for (i = 0; i < 1023; i++) //READING FROM SENSOR TO RAM
  {x[i]=spi(0x00);}
  i=0;

  for (i = 0; i < 1023; i++) //SENDING DATA FROM RAM TO SERIAL LINE
  {putchar(x[i]); }
}
  
```

Fig. 5 Program for microcontroller ATMEGA644P.

#### 5 Control program for PC

Control program for PC has been written in LabVIEW, which is an object oriented development system, in which the program code is generated by connecting prearranged functions to the block diagram.

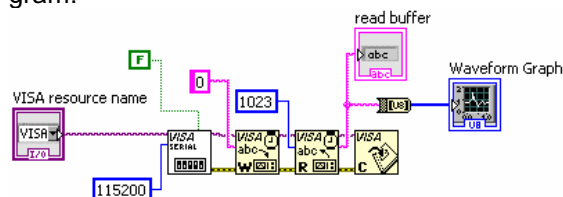


Fig. 6 Control program in LabVIEW.

The control program sends to device 1 byte and subsequently receives 1024byte of data which projects to the graph. For control the data are written out in the text (ASCII) form also.

#### 6 Application in spectroscopy

To test an operation of our device an experiment has been made [4]. The results of this experiment are in fig. 7 and 8.

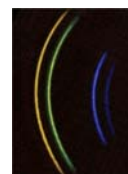


Fig. 7 Emissive bars of mercury lamp

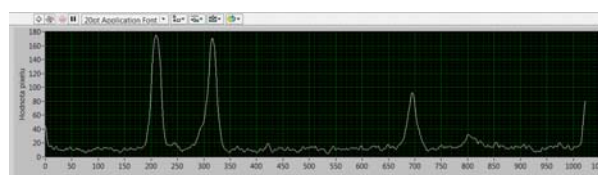


Fig. 8 Spectra measured by sensor S10077(LabVIEW)

#### 7 Conclusion

The interface of CMOS S10077 (Hamamatsu) sensor offers communication with any personal computer (PC) through standard USB bus, so no additional cards, converters or driver libraries are needed. Due to its simplicity and low cost it can find a wide application as in industry as in education.

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#### References

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