Advertising LED system using PIC18F4550 microcontroller and LED lighting

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ABSTRACT: In recent years, interest of the LED lighting is increased drastically in different applications. The reason for that are great advantages LED lighting. Advantages are: small dimensions, low power consumption, long life (up to 50 000 hours), top colorful solution (RGB lighting) and ability to adjust thebrightness. System enriched microcontroller can in many cases replace the man. Such system reduces dimensions of device and power consumption. Reason for that are very good features of microcontrollers: small size, can be programmed, minimum number of external components are required for normal operation, very long life, ect. In this paper, we described method of designing advertising LED system using PIC18F4550 microcontroller. LED stripsare usedfor making letters and*light-emitting diodes*are used for additional effects. The PIC18F4550 microcontroller is used to control advertising LED system (on/off letters and additional effects). We conducted analysis of electricity consumption creation ofadvertising LED system.For additional savings of electricity consumption is integrated infrared motion sensor. In this way is enabled long-term operation advertising LED system especially in rural areas in conditions where LED advertising system is powered by battery or powered by combination of batteries and photovoltaic cells.

KEYWORDS: PIC18F4550 microcontroller, LED lighting, MPLab, ICD2 programmer, infrared motion sensor.

1. Introduction

The occurence of microcontrollers and microprocessors are regarded as one of the greatest technical achivements that characterized twentieth century. Main difference between microcontrollers and microprocessors is that they are the first optimized for speed and performance with computer programs, while microcontrollers are optimized towards integration of a large number of circuits real-time control, mass production, low cost and low power consumption [1]. Microcontrollers are also more resistant on variation of voltage, temperature, humidity, vibration, etc. Huge adventage is reflected in the fact that can be programmed, beside Assembler, and in high-level programming languages: C, Pascal, Basic, etc. [2]. This increases number of users who can write programs and thus also apply [1], [3]. They are used in a wide variety of modern devices such as: robots, telecommunication devices, satellites, cars, measuring instruments, mobile phones, cameras, etc. Also they are widely used in many home devices such as washing machines, microwave ovens, breadmakers, etc. [3]. Today on market there are few major manufacturers microcontroller which in its production program have different microcontroller familys. The most popular of them are Intel, Motorola, Atmel and Microchip. In this paper is used PIC18F4550 microcontroller [4], [5], [6].

LED lighting is based on light-emitting diodes (LED) which emitting light when electric current trought them. Color of light emitted by such LEDs depends on a few factors of which the most important are semiconductor and additional admixtures. LED light can

variate from infrared to ultraviolet part of spectrum [7]. The first commercial use of LED lighting is focused on various indicators in electrical technology. Initially they were applied only to expensive equipment in laboratories. Later, LED lighting has found its usage in many electrical devices such as TVs, telephones, watches, calcurators, lighting, etc. With development of LED technology is increasingly being directed towards to lighting. LED lighting consumes up to 60 % less energy so that a lightly higher price can compensate with saving trought few years [8].

In this paper is designed adversting LED system using PIC18F4550 microcontroller and LED technology. ON/OFF control of letters and additional effects is completely controlled by PIC18F4550 microcontroller, which is programmed in programming language Assembler. For additional savings of electricity consumption is embadded infrared motion sensor. Also, it's performed analysis of electricity consumption created advertising LED system.

2. The PIC18F4550 microcontroller

The PIC18F4550 microcontroller belongs 18F series of microcontrollers from Microchip company [4], [5]. Microcontrollers of this manufacturer are characterized by low cost and more importanly free technical support (compilers, development systems) [5].

Considering to own harvard structure, memory map is divided in program memory, data memory and EEPROM. Processor in microcontroller (CPU) uses a technique of overlapping. Purpose of that is all instructions are executed (except branching) in one cycle. For these reason the basic tact is divided by 4, because the phase of execution of commands are overlaping. All commands have fixed length 2 bytes which means that memory adressing is limited. Memory is divided in 16 pages, and selection of pages is performed in appropriate control registers. This feature significantly slows microcontroller. However, advanced compilers preform intelligent plannigalocation of memory how would variables, that are commonly used, be located in the same memory bank.

Program memory is 32 KB and the RAM size 2 KB. There is also 256 BEEPROM memory [4], [5]. Processor has extended instruction set compared to the earlier series (16 and 17) as well as new ways of addressing. That way commands are added on hardware multiplication and division, incrementing and decrementing with conditional leap, etc. Program counter has width 21 bits and it can be accessed only indirectly trought certain registers [9], [10]. Microcontroller also has buffer (stack), but unfortunately can only be used indirectly writing desired content in the special register and then with special instruction contents of the register puts in buffer. Datas are also located in that register. Peripherals tact depends by frequency of oscilator. Frequency of oscilator is maximum 48 MHz, which gives processor of microcontroller 12MHz. For this purpose is used PPL circuit and frequency dividers. The most important thing is that for work of USB module microcontroller must be provided external tact of 24 MHz. PIC18F4550 microcontroller has adventage over competing microcontrollers because tact can be independent of tact for CPU [4]. Mechanism of interruption is organized as a single interrupted vector. It contain address of interrupt routine in which is need to examine source of interruption and define desired action. There is no interrupted vector for each group or interrupted sources, wich is one of the disadventages of microcontroller. Because of that it loses its speed and transparency. The PIC18F4550 microcontroller has numerous collection of hardware peripherals that enable implementation in many applications. Microcontroller owns 35 I/O lines that are multiplexed with parts of data register and signals of other modules [4]. In Figure 1 is

shown package of microcontroller in 44-pin and 40-pin package [4], [5].

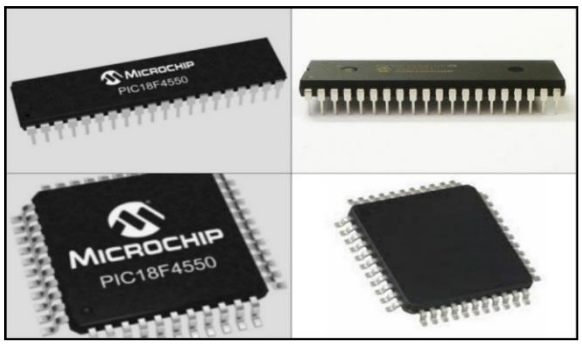

Fig. 1 The PIC18F4550 microcontroller in 44-pin and 40 pin package

Operating modes PIC18F4550 microcontrollers are [4]:

- Run mode: CPU and peripherals are turned on.
- Idle mode: CPU is turned off, peripheral is turned on and current is up to 5.8 μA.
- Sleep mode: CPU and peripherals are turned off and current is up to 0.1 μA.

Memory of PIC18F4550 microcontroller is organised in three different memory [5]:

- Program memory
- Data memory (RAM)
- EEPROM data memory

Data memory and program memory are separated, which enables access for both memory in the same time. EEPROM data memory for practical implementationcan be considered as peripheral device. Also, EEPROM data memory access over control memory [5]. Microcontroller series PIC18 are integrated such as 21-bit program counter. Addressof program memory (2 MB) is enabled using program counter. If access memory location in between 2 MB, access is regular. If access memory location over 2 MB than result is logic „0“ (NOP instruction). The PIC18F4550 microcontroller has Flash memory capacity 32 MB and can write 16 384 instruction [5].

Microcontroller serves PIC18 are using two interrupt vectors:

- Reset vector whose address is 0000h
- Interrupt vector whose address is 0008h and 0018h

In Figure 2 is shown PIC18F4550microcontroller in DIP-40 package.

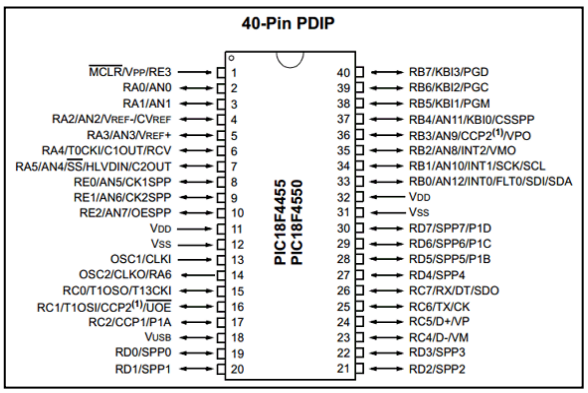

Fig. 2 The PIC18F4550 microcontroller in DIP-40 package [4], [5].

Each of 40 pins has its own label and generally more purpose. That is used to reduce number of pins. While programming, purpose of pins can be defined.

3. Led lighting

LED (Light Emitting Diode) lighting is growingvery quickly and showing as the „lighting of the future“. Currently, LED lighting is used in traffic signals, automobile industry, backlights of televisions and monitors, phones with camera and also in many applications for decorative lighting, internal and external both [11].

In Figure 3 is shown various implementations of LED lighting.

LED lighting is based on semiconductor LEDs that are emiting light when electric current flows trough them. Color of light emitted by LEDs, depends of several factors. The most important factors are semiconductor and added impurities.

Rangeof light is from infrared to ultraviolet part of spectrum.

Fig. 3 Various implementations of LED lighting

Public interest for LED lighting in various applications has increased drastically in recent years. Popularity of LED lights is growing mainly because it following all basic trends. Lighting objects can be small, sophisticated and enabled extra multicolored solution (RGB lighting).

LED lighting provides whole new perception of lighting and swiching from „era bulb“ to „era of digital and creative lighting“. LED lighting is no longer pure, static need for light, but now it presents constitutive part of design for interior and exterior. Permanent drastic progress in development of LED lighting, which includes much improved preformance of diodes, also appropriate optics, opens up endless possibilities for lighting solutions. It enables modern architectural solution and has become constitutive part of modern design [12].

Adventages of LED lighting over conventional light sources are [12]:

- Incomparably improved uniformity of light in comparison with other conventional light sources
- Lower power consumption
- Average duration is 10 to 15 years
- Resistance to mechanical demage and vibration
- No UV or IR radiation
- With instantly turning on there is no strobo effects
- Very small dimensions.

Such as all new tehnology that drastically progresses, LED tehnology has also a few disadventages [12]:

- Start price
- Heat sensitivity (reduce the efficiency at higher temperatures)
- Weak horizontal dispersion
- New technology (lack of consultation, advice and implementation).

LED light sources also provide possibility of light direction of light (narrow beam of light), reducing unnecessary spending light. LED lighting produces less pollution of light, but at the same time possibility of much more efficient and precise deployment lamps.

4. Advertising led system using PIC18F4550 microcontroller and led lighting

In this paper is designed advertising LED system using PIC18F4550 microcontroller and LED lighting. For creation advertising LED system are used: PIC18F4550 microcontroller, LED strips, LED lamps, adapter, infrared motion sensor, 24 transistors working as switches and plexiglass size 70x70, ect. On plexiglass is glued photofoil with desired motive in which are carved letters and desired shapes.

In Figure 4 is shown LED stripes which are shaped on appropriate size and placed on appropriate place on plexiglass.

Each letter has two connectors (for positive and negative pole) which are connected on circuit board with transistors which are working as switches. Power supply for advertising LED system has two voltage levels. First voltage level (12 V) is used for power part and LED stripes. The second voltage level (5 V) is used for PIC18F4550 microcontroller and its development environment. For this purpose is used

integrated circuit LM7805 on whose output is obtained stable voltage of 5 V which is required to operate PIC18F4550 microcontroller. Energy part of circuit is necessary because PIC18F4550 microcontroller on output pins provides voltage of 0 or about 5 V, and LED stripes works at 12 V with much higher consumption.

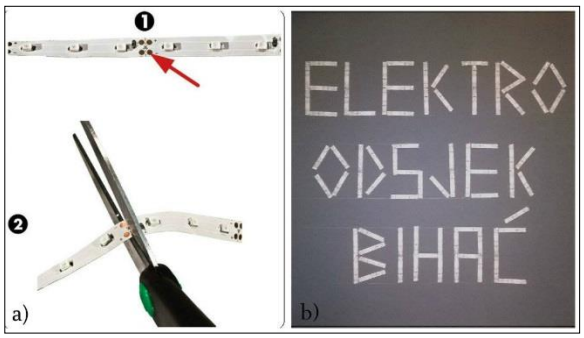

Fig. 4 a) Cutting LED stripes, b) placing LED stripes on appropriate place on plexiglass

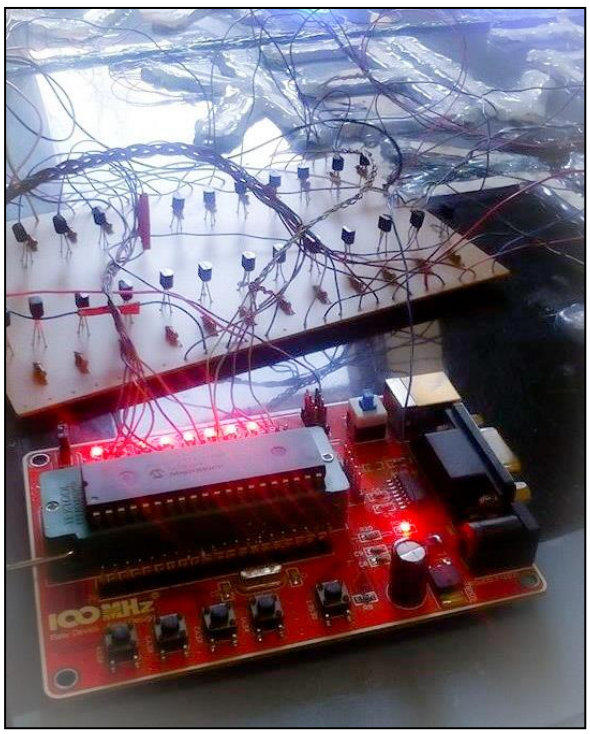

Fig. 5 Energy part of circuit, development environment and PIC18F4550 microcontroller

For programming PIC18F4550 microcontroller is used development environment MPLAB. Program is written in programming language Assembler. Using ICD2 programmer, hexadecimal code is transfered in PIC18F4550 microcontroller.

In Figure 5 is shown energy part of circuit, development environment and PIC18F4550 microcontroller.

As the output ports are used PORT A, PORT B, part of PORT C and PORT D, and as input port is used PORT E (pin RE0) on which is connected infrared motion sensor [13]. This sensor enables that advertising LED system is turning on only in someone's presence. Otherwise advertising LED system is turned off. In Figure 6 is shown infrared motion sensor and the way it works.

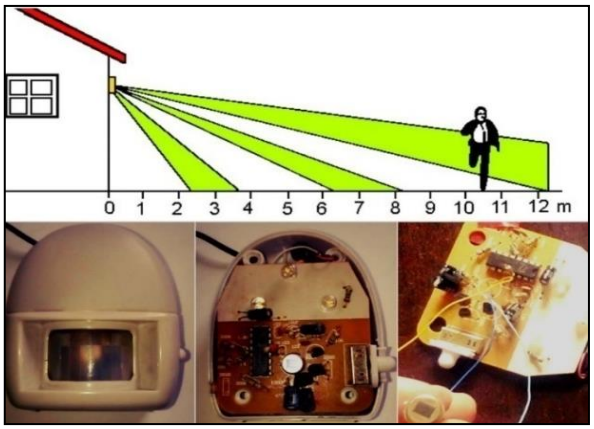

Fig. 6 Infrared motion sensor

This enable reducing power consuption when there is no presence of motion infront of advertising LED system. It is important when advertising LED system is powered by battery or powered by combination of batteries and photovoltaic cells. In Figure 7 is shown apperiance of advertising LED system when power is turned off.In Figure 8is shown final apperiance of advertising LED system (power is turned on).

On advertising LED system, letters „ELEKTRO ODSJEK“ are blue color, and letters „BIHAĆ“ are white color. LED diodes which are placed on sides are green color.

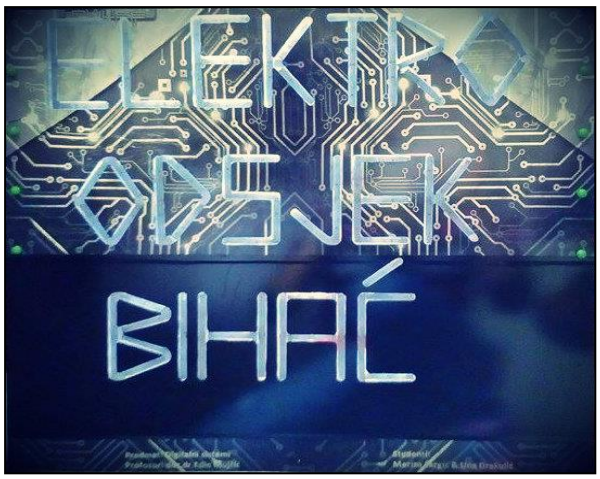

Fig. 7 Apperiance of advertising LED system

Maximum consumption electrical current when all letters and LED diodes are turned on is 15.24 Wh. Average consumption advertising LED system is 6 Wh, while minimum consumption (when is only one letter turned on) is 1.8 Wh. In case when advertising LED system is powered by battery 100 Ah, advertising LED system can work constantly about 8 days. Using infrared motion sensor that time period is significantly prolonged.

Fig. 8 Finale apperiance of advertising LED system

5. Conclusion

In this paper is described way to design light advertising LED systemusing PIC18F4550microcontroller and LED technology. LED strips are used for making letters and LED diodes for additional effects. Control of advertising LED system, turning on and off letters and diodes, is controlled by PIC18F4550microcontroller. Based on analysis of average power consumption. We can conclude that consumption is very low compared to any other technology for lighting. Using motion sensors consumption is significantly reduced.

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