DEVELOPMENT OF AN ELECTRONIC CIRCUIT FOR SOLAR CELLS USED IN AMBIENT LIGHTING

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Abstract: *This article aims to demonstrate the main features of a project to control a light luminary that uses solar power cell battery, which in turn provides energy to the circuit designed. The electronic circuit presented provides an idea of how it is possible to adapt our everyday circuits for electric energy use more sustainable, without losing quality and offering an alternative to the problem we face today in relation to impacts caused by current energy sources.*

Keywords: *Solar Cell, Electronic circuit, Photovoltaic, Lighting Luminary.*

1. INTRODUCTION

The current forms of energy that we are finite and causing impacts to the environment, often irreversible, demonstrating the clear need for developing new sources of energy, renewable and non-polluting. Several countries have sought to invest and develop technically and economically viable technologies for solar energy utilization, analyzing incidence which reaches Earth until the process for manufacturing of cell.

Photovoltaic technology offers several advantages versus conventional methods of obtaining electrical power that deserves greater prominence is that it is the largest renewable energy source in the world, energy that can be obtained regardless of the climate of the place where you want to install such technology. Being a great source of free energy, photovoltaic in long term and with greater dissemination contributed to the reduction of carbon dioxide emission. Taking as an example the England, for each 1,0 kWp photoelectric energy generated, ceases to generate 1,0 Ton of CO_2 per year. Another advantage that should be highlighted is the scale factor, allowing a good flexibility for energy levels, from miliwatts to megawatts which is possible due to the modular technology cells.

The purpose of this luminary design which uses photovoltaic cell is exemplify an application of the use of this technology, and promote the spread of this source of energy which we use very little. A circuit was developed to a prototype of a luminaire that allows the user to a different interaction found on the market, such as the changing of the colors within the range comprised of RGB LEDs. The use of semiconductor components is consistent with the idea of using electricity more effectively, given the low consumption of these components for its functioning.

2. OPERATION OF THE CIRCUIT

The FQP15P12 transistor performs switching between the battery and the circuit according to the voltage of the solar panel and battery. When the solar panel has lower voltage that the battery, so that food becomes the circuit, thus linking the PIC micro controller.

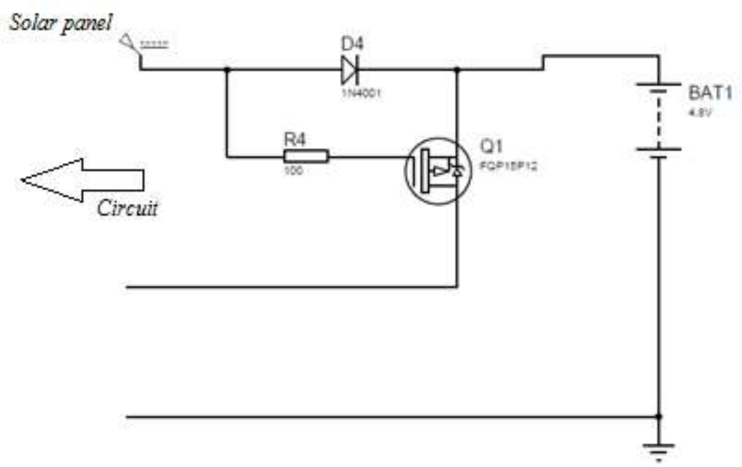

Figure 1. Switching between solar panel and battery.

From a potentiometer of 100 Ω, is varied to tension on the port from the GP2 micro controller, which checks in your programming which the same port must be thrown, as the "table 1".

Table 1 – voltage levels depending on the door thrown.

Voltage (V)	Triggered Port (PIC)	Color
< 0,45	No	Turn off
0,45 a 0,90	GP0	Blue
0,90 a 1,35	GP1	Green
1,35 a 1,80	GP0; GP1	Acqua
1,80 a 2,25	GP4	Red
2,25 a 2,70	GP0; GP4	Purple
2,70 a 3,15	GP1; GP4	Yellow
> 3,15	GP5	White

Micro controller ports do not allow higher current to 20 mA, and thus can connect only one LED, so we use a CI current gain, ULN2803 receives the signal micro-controller, and then passes its output to current drain, allowing a chain 10 times larger than micro controller.

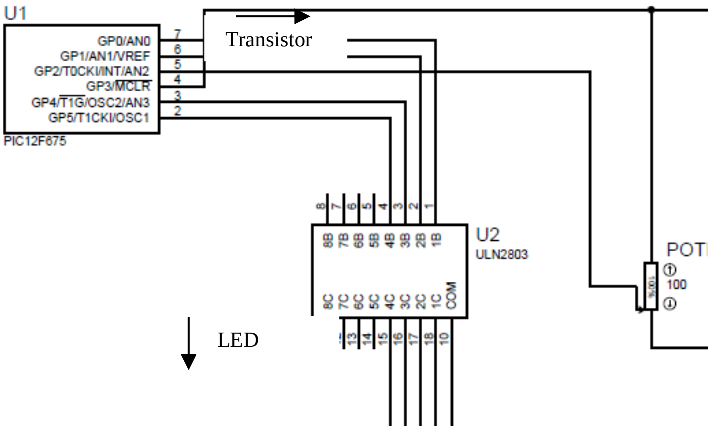

Figure 2. PIC and ULN2803.

3. PIC PROGRAMMING

For programming the PIC is necessary to parameterize the CLUBE NAUTICO loggers, GPIO, ADCON0, ANSEL and CMCON.

- ✓ *CLUBE NAUTICO:* Is the Registrar that configures the pins as input or output. With the pins 0 become 1, output pins are configured as input. An exception is the PIN GP3, which is only input, and your TRIS bit will always read as ' 1 '.
- ✓ *GPIO:* The GPIO pins configured as high (1) or low (0). The GPIO is directly linked to the CLUBE NAUTICO recorder, once configured the CLUBE NAUTICO, is required only to start the GPIO register.
- ✓ *ADCON0:* This recorder is part of the configuration of the port reading/d. Where is selected the shape of the result obtained, the reference voltage of the bit, the analog channel selection of bits, read cycle activation and operation of the converter module.
- ✓ *ANSEL:* This recorder is part of the configuration of the port reading/d. Where is selected the conversion bit clock and door configuration in analog or digital.
- ✓ *CMCON:* This module performs comparison of the analog values of the doors.

```
float temp_res;
int i;
void main()
{
    TRISIO = 0b00000000;
    GPIO   = 0;
    ADCON0 = 0b10001011;
    ANSEL =  0b01100100;
    CMCON =  0b00000111;

    do{
    temp_res = Adc_Read(2);
    temp_res = (temp_res*0.0048);

    if(temp_res>=3.4){
                      GPIO = 0b00100000;
                     }
    else if(temp_res>=2.9){
```

```
                    GPIO = 0b00010010;
                    }
    else if(temp_res>=2.35){
                    GPIO = 0b00010001;
                    }
    else if(temp_res>=1.9){
                    GPIO = 0b00010000;
                    }
    else if(temp_res>=1.4){
                    GPIO = 0b00000011;
                    }
    else if(temp_res>=0.9){
                    GPIO = 0b00000010;
                    }
    else if(temp_res>=0.46){
                    GPIO = 0b00000001;
                    }
    else if(temp_res<=0.45){
                    GPIO = 0b00000000;
                    }
                   } while(1)      ;
     }
}
```

Figure 3. Programming in C language.

To decrease the power consumption of high brightness LEDs were included in the circuit, because to have the white color in the light luminary would need to light up all the color in RGB LEDs, which would entail a consumption of 20 mA for each color on each LED, i.e. have a total consumption of 540 mA for 9 LEDs.

Table 2 – Cost of components.

Quantity	Description	Price in R$
1	pMOSFET channel FQP15P12 Transistor	5,16
1	PIC 12F675	3,80
1	ULN2803	1,50
1	1N4001 Diode	0,05
37	Resistor 100 Ω	0,04
1	Potentiometer 100 Ω	1,50
9	5050 SMD RGB LED	0,25
9	White LED 5 mm	0,46
3	KRE 2 points borne 10 mm	0,50
1	KRE 3 points borne 10 mm	0,60
1	Phenolic paper borad 10 X 15	3,00
1,0 m	0.20 mm^2 flexible wire	0,35
1	Solar panel 5.0 V, 140 mAh	20,00
1	Ni – MH Battery 4.8 V, 2300 mAh	15,00

Grouping all topologies used, the circuit of Figure 4.

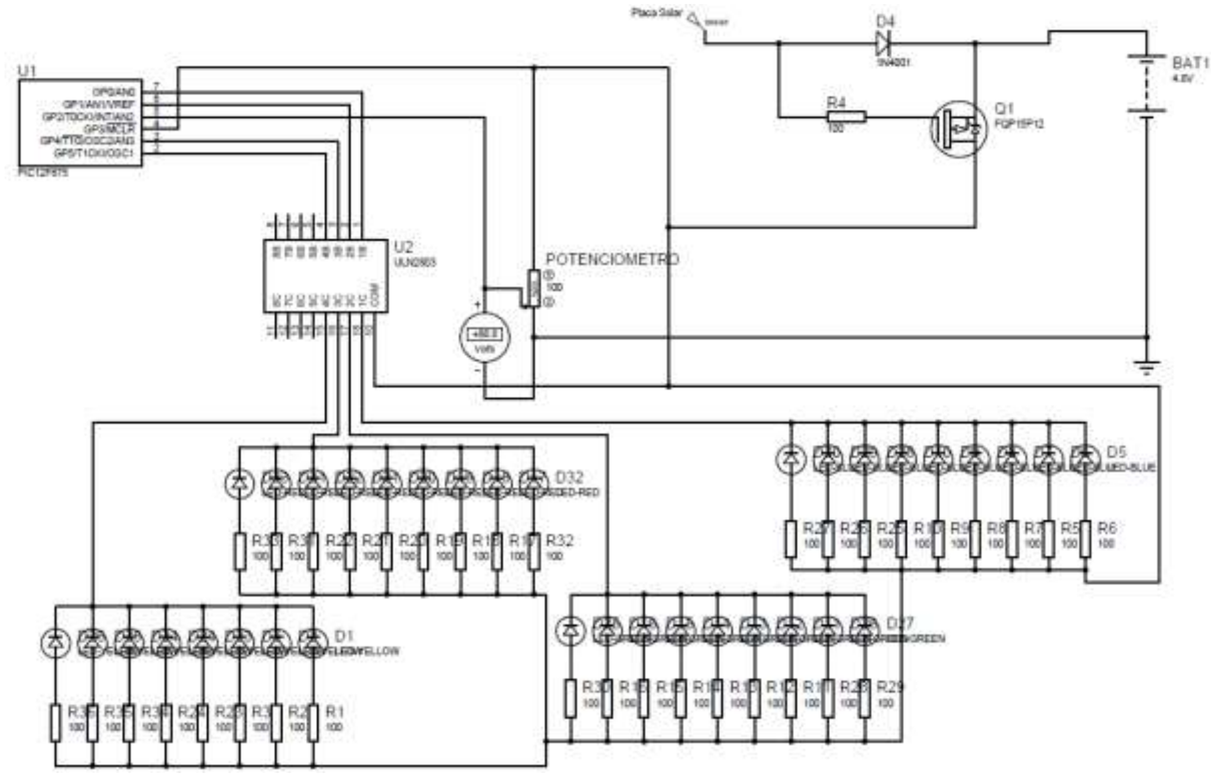

Figure 4. Complete Solar Lamp circuit.

4. LOADING AND UMLOADING TIME OF THE PIC

The real advantage of using a Ni–MH battery is in the cycle of life (reuse after reload). Typically these batteries can be recharged hundreds of times, enabling the equivalence of their life cycle equal to hundreds of alkaline batteries, however its lifetime is limited to five years or less, yet presents itself as a great option to operate in electronic equipment of our daily life.

4.1. Load time.

The plate with photovoltaic cells produces on average a voltage of 5.0 V and a current of approximately 220 mA, Ni-Mh battery has a total capacity of 4.8 V and current of 2300 mA. Based on this information, the estimated time to charge the battery, T_C is given by the equation below:

$$T_C = \frac{I_{bat}}{I_{solarpainel}} x1,4 \tag{1}$$

Where: I_{bat} the total current of the battery; $I_{solarpainel}$ the current generated by the solar panel. The voltage required for an optimal recharge is established by the factor 1.4. This factor is related to voltage of each cell in the battery to full charge. In this way, the estimated time of Valley load:

$$T_C = \frac{38,33h}{3,667h} x1.4 = 14,63h \tag{2}$$

4.2. Discharge time

The estimated time for the discharge battery, or battery life is defined by the equation below:

$$D_b = \frac{C_b}{C_C} \qquad (2)$$

Where: C_b represents the battery capacity, expressed in mAh; C_C the charge current required for the load (luminary) is supplied. In the case of the luminary the estimated consumption is between 180-360 mA. With a fully charged battery is able to supply 2300 mAh, so we calculate the average duration of solar light fixture for each color, as shown in the "table 3".

Table 3 – Estimated battery average for each color.

Colors	Charge current (mA)	Time battery (hours)
Blue, green and red	180	12,7
Acqua, purple and yellow	360	6,4
white	270	8,5

5. Board Layout of the prototype.

For preparation of the prototype was used as the basis of the circuit have simulated the Protheus. In order to include the circuit in the structure of the lamp were used two printed circuit boards, one for the core of the circuit as shown in the figure "5" and another for the LEDs and resistors, "Figure 6."

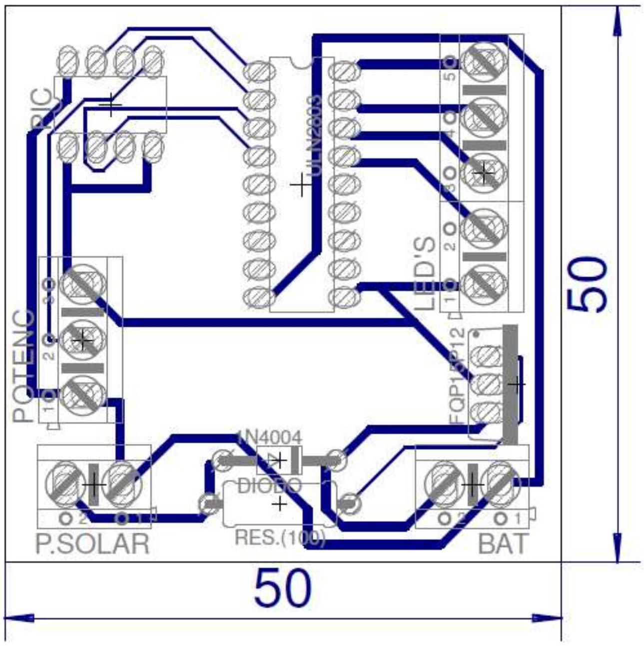

Figure 5. Board Layout containing the core of the circuit.

The layout design of the plates was done at the Eagle, software intended to layout design of printed circuit boards. To reduce the cost were used printed circuit boards of phenolite with just a layer of metal (copper).

On the plate shown in Figure 6, the resistors are arranged between the LEDs and the power bus-V_{CC} circulates all over the plate. How to decrease the dimensions of the plate, reducing its area, were used jumpers to the resistors. In addition, it has been used suspended between two connection points, off the plate tracks, to facilitate the routings.

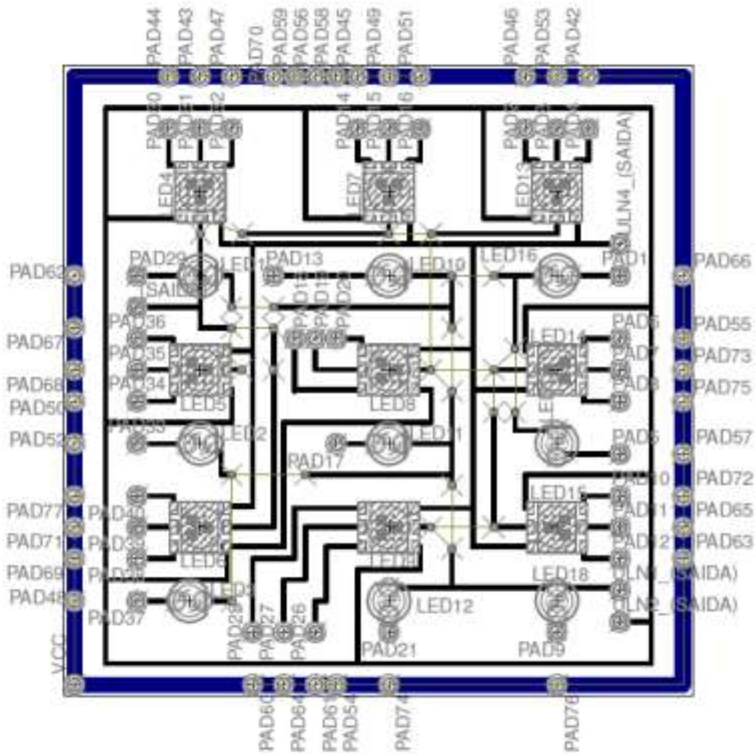

Figure 6. Board Layout containing LEDs and resistors.

5. CONCLUSION

After practical tests concluded that the prototype was a success, the lamp works with a brightness greater than those found in the market today, has more features, since it is possible to change the colors whenever you want, your time is over and if produced in large scale comes at a cost compatible or even lower. Solar energy is an abundant source of energy in our planet and very little explored. It is extremely important that Government incentives to continue searches for a solar cell that has a better efficiency and greater economic viability, because we are able to explore more of this inexhaustible and clean energy source that is increasingly intense in our daily lives.

6. REFERENCES

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