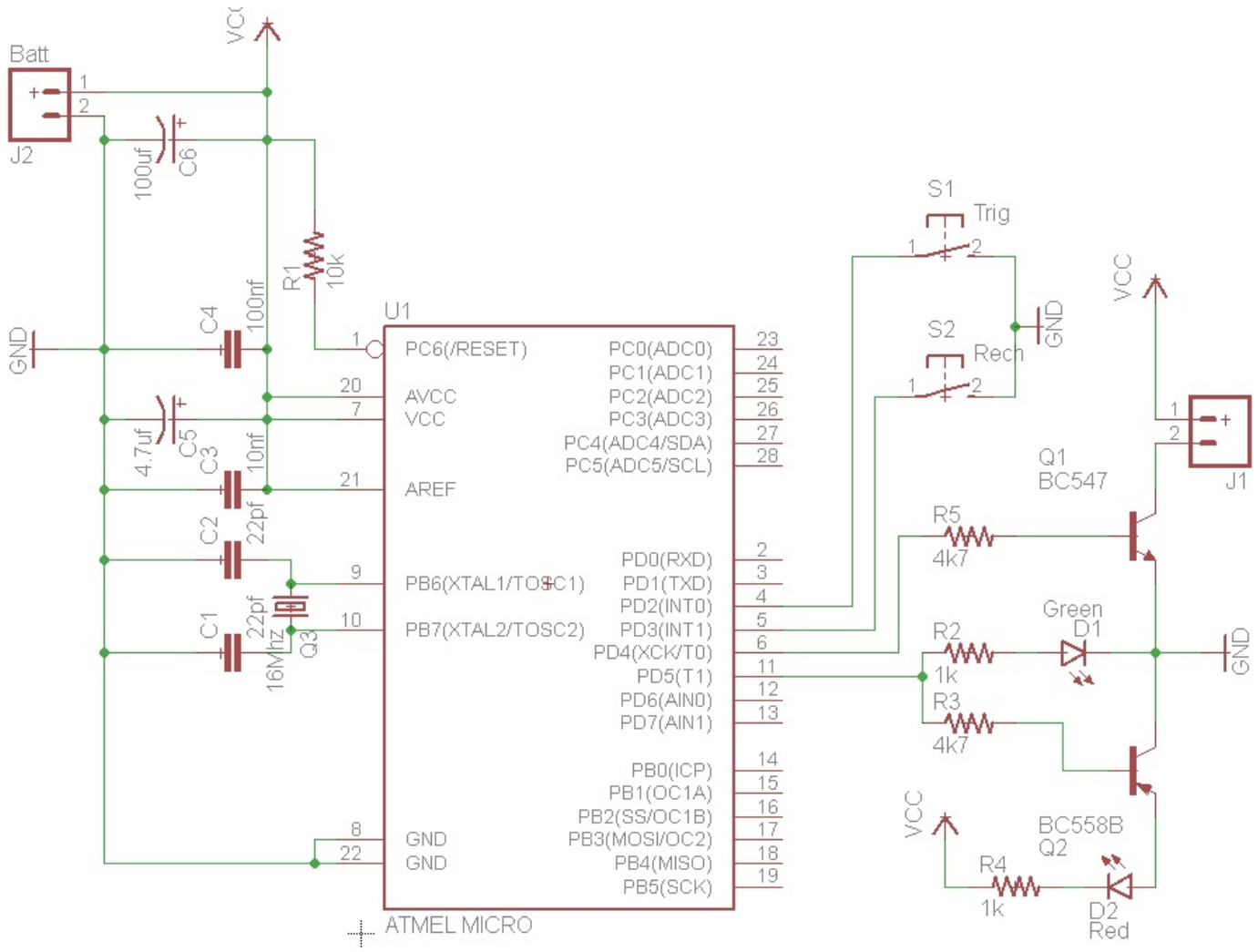
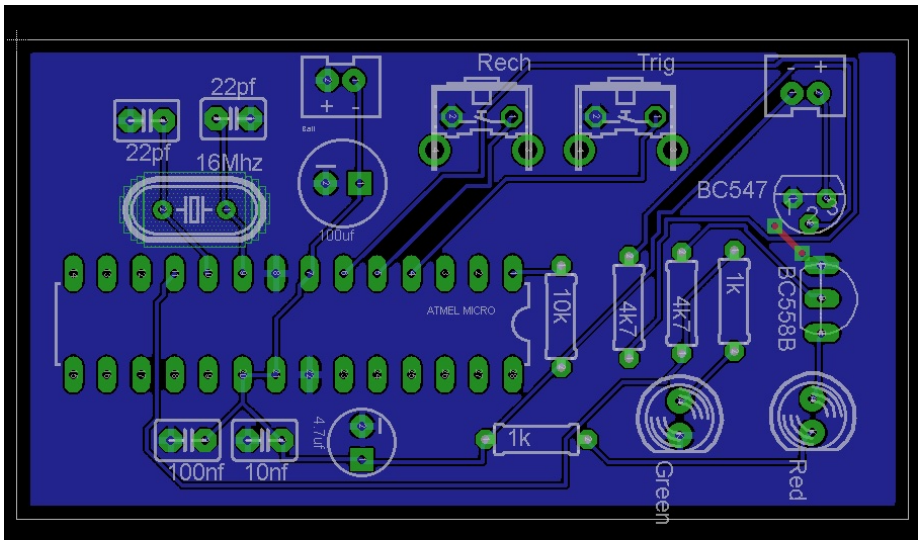
## CARACTERÍSTICAS DO PROJETO

O projeto consiste em adaptar o seguinte circuito, que comanda um diodo laser, para que funcione nas especificações que serão dadas adiante. Além disso, consiste, também, em corrigir qualquer possível erro de projeto que faça este circuito não funcionar, conforme as especificações, que também serão demonstradas a seguir.



**Características do circuito:**

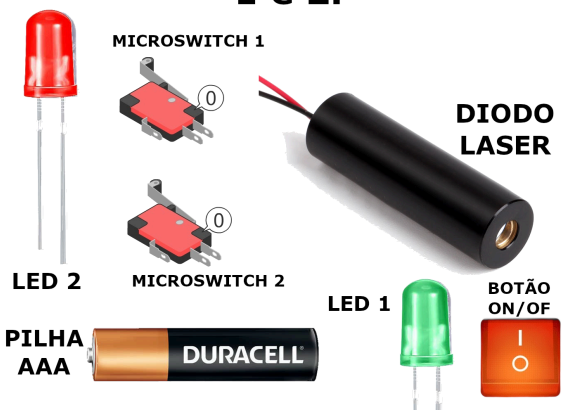
1 - O sistema é composto por:

A) Um diodo laser;
B) Dois microswitchs;
C) Dois leds;
D) Um botão de liga e desliga;
E) Uma bateria (a princípio, deveria ser uma pilha AAA, mas é aceitável adaptar outro tipo de bateria, desde que combinado antes);
F) Uma placa controladora, que não consta na imagem.

2 - Sistema em repouso:

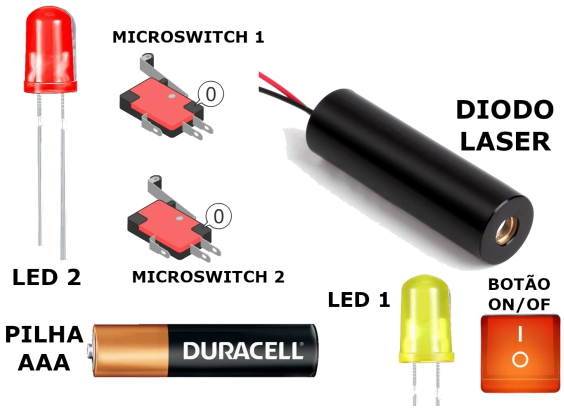
3 - Quando o botão de liga e desliga (on/off) é acionado, acendem os dois leds (Led 1 e Led 2). O Led 1 acende em cor conforme a carga da bateria, se a bateria está com o máximo de carga, ele deve acender em verde, se a bateria está mais fraca, o Led 1 deve ir mudando de tonalidade conforme a quantidade de carga, passando para amarelo, laranja e então vermelho, sendo esta última cor indicativo de que a bateria está praticamente sem carga. O Led 2 deve acender em vermelho (mais explicações adiante). Em teoria, esta funcionalidade já está OK, no esquema fornecido.

**Quando o botão de liga e desliga (on/off) é acionado, acendem os leds 1 e 2.**



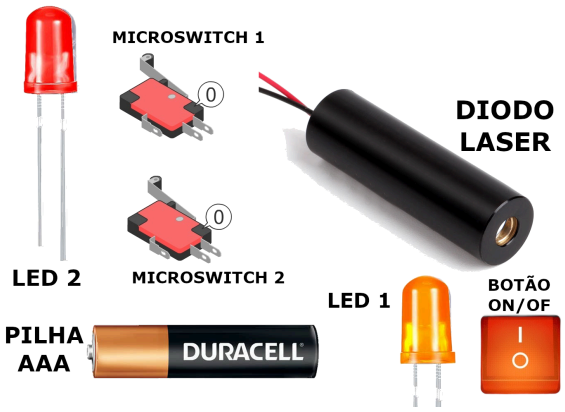

Sistema com carga máxima

**O Led 1 vai mudando de cor, conforme a carga da pilha vai enfraquecendo.**



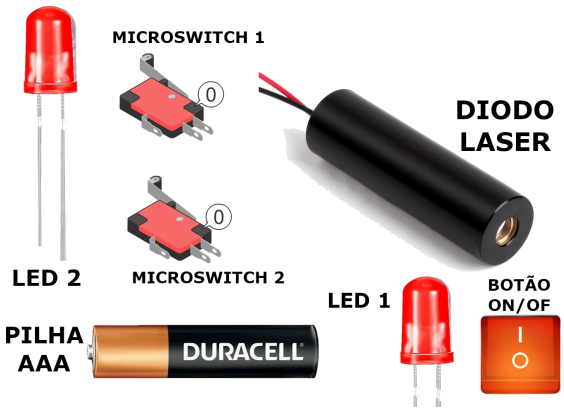

Sistema com um pouco menos de carga

**O Led 1 vai mudando de cor, conforme a carga da pilha vai enfraquecendo.**




Sistema com carga relativamente baixa

**O Led 1 vai mudando de cor, conforme a carga da pilha vai enfraquecendo.**




Sistema com carga muito baixa

4 - Neste estágio, circuito ligado, com o Led 2 ainda em vermelho, se o Microswitch 1 é acionado, nada deve acontecer. Em teoria, esta funcionalidade já está OK, no esquema fornecido.

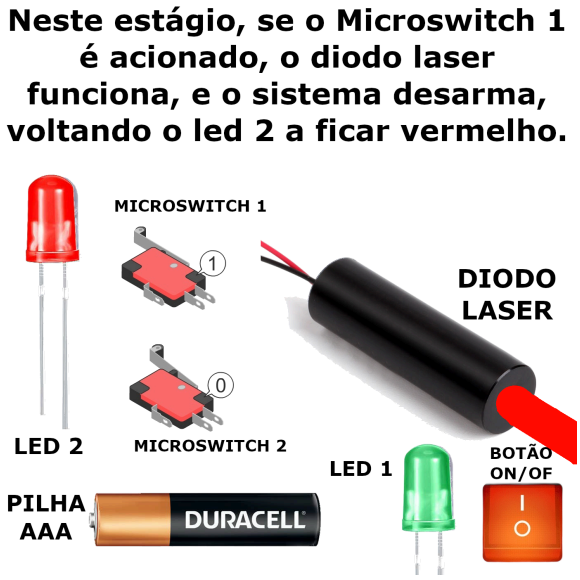
Microswitch 1 não acionado

Microswitch 1 acionado, mas nada acontece.

5 - Neste estágio, se o Microswitch 2 é acionado, o sistema fica “armado”, e o Led 2 muda de cor para verde, indicando que o sistema está pronto para acionamento do Diodo Laser. Em teoria, esta funcionalidade já está OK, no esquema fornecido.

Microswitch 2 acionado, Led 2 fica verde e o diodo laser vai funcionar se o Microswitch 1 for acionado.

6 - Neste estágio, com o Led 2 em verde, se o Microswitch 1 é acionado, o Diodo Laser funcionará e disparará um feixe laser. Após o “disparo”, o Led 2 volta a ficar vermelho, indicando sistema desarmado. Em teoria, esta funcionalidade já está OK, no esquema fornecido.




Após o disparo, o Led 2 volta a ficar vermelho.

7 - Então, todo processo deve se repetir, para haver novo disparo do Diodo Laser. O Switch 2 deve ser acionado novamente, “armando" o sistema, o Led 2 deixa de ficar vermelho e passa a ficar verde, e o Switch 1 deve ser acionado para o Diodo Laser realizar um novo disparo. Em teoria, esta funcionalidade já está OK, no esquema fornecido.

Um exemplo do todo funcionamento do circuito fornecido pode ser visto no GIF a ser acessado no seguinte endereço eletrônico: https://gifyu.com/image/ScNBm

Segue outro exemplo, em GIF, do sistema em funcionamento, em laboratório, no seguinte endereço eletrônico: https://gifyu.com/image/ScNGV

## TAREFA 1

Confirmar se tudo está correto, conforme o descrito, e especificar uma bateria e o hardware necessário. Esta tarefa corresponde a 5% do projeto.

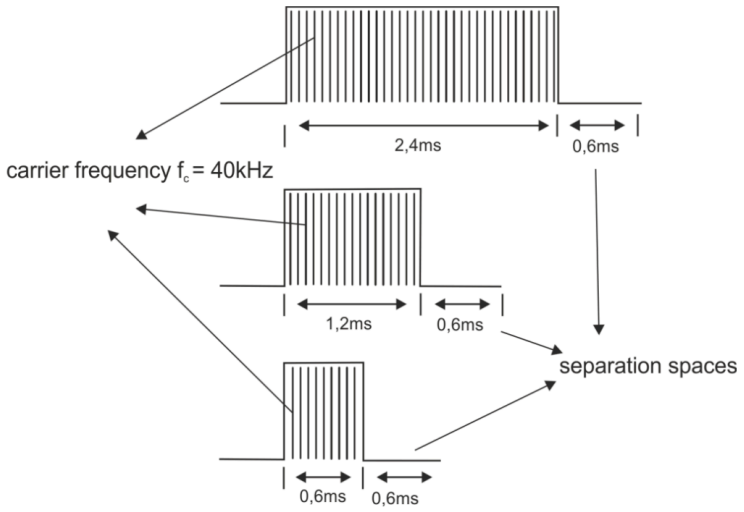
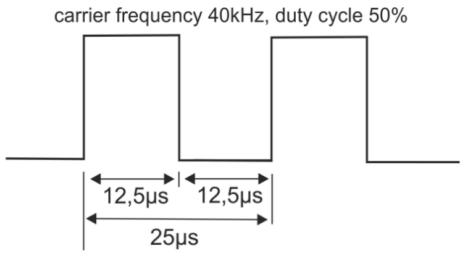
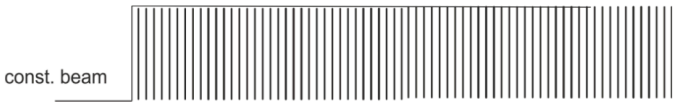
# TAREFA 2

Adicionar som ao projeto. Adicionar algum tipo de hardware que faça som quando o laser é disparado. Esta tarefa corresponde a 5% do projeto.

# TAREFA 3

Criar o “modulador/controlador”, para o Diodo Laser, que o faça o feixe laser funcionar com as seguintes frequências e características (esta tarefa corresponde a 85% do projeto):

1 - Para fins de projeto, vamos nos referir ao sinal como “UIPM Signal 15.6”. O sinal deve ter as seguintes características (as especificações não foram traduzidas para o português para evitar qualquer tipo de inconsistência em relação aos termos que são técnicos e próprios da área de eletrônica):

| | |
|---|---|
| **start sequence:**<br>width: 2.4ms/ space: 0.6ms<br>approx. 96 pulses if $f_c$ = 40kHz;<br><br>**logical ‘one‘:**<br>width: 1.2ms/ space: 0.6ms<br>48 pulses (fc = 40kHz)<br><br>**logical ‘zero‘:**<br>width: 0.6ms/ space: 0.6ms<br>24 pulses (fc = 40kHz) |  |
| **Carrier frequency ($f_c$)**<br>$f_c$ = 40kHz<br>duty cycle = 50%<br>pulse periode = 25µs<br>Laser on time = 12.5µs |  |
| **Constant beam/basic**<br>width: not defined<br>modulated signal (fc = 40kHz)<br>undefined number of pulses/fc = 40kHz |  |
| **optical signal parameter** | Laser wavelength: 635nm - 650nm; ±5nm<br>beam waist/ diameter: max. 6mm at 10m distance<br>Laser peak power: check peak power table (IEC 60825-1) and the current UIPM rules |

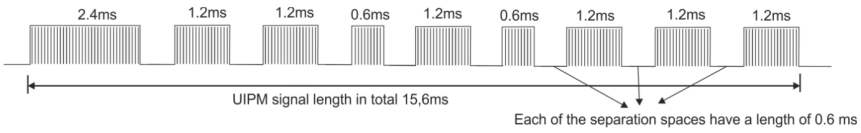
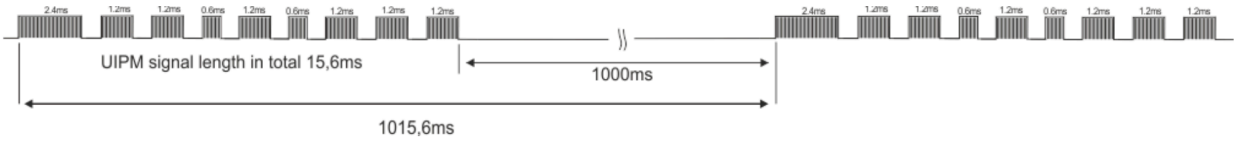
The

UIPM Signal consists of two independent parts, the modulation and of the code shape (a static code structure).

**The Code shape is defined as a time sequence to get a static Code**
A Unique Signal which should be different to other Signals in the surroundings. The Identification as a valid UIPM shot signal is realized by analyzing the code shape of a received signal by the target electronics.

**The modulation is defined with independent frequency parameters**
This modulation frequency was established to reduce interference effects with ambient light like sunlight. Sunlight is DC light without a timely defined modulation shape. The target electronics should use a suitable filter to suppress the ambient light components.
In result, the target will be more sensitive for a weaker shot signal, even in case of bright ambient light.

| | |
|---|---|
| Modulation frequency | The Modulation frequency is defined as a Carrier frequency. We do not change this carrier frequency in no way, but we switch on-off this carrier signal in relation to the specified code structure.<br>The specification of this carrier signal with fc = 40kHz is given by certain time parameter (duty cycle, pulse period, and the signal On-time, which equals to the Laser On-time. The decision to use this signal definition was made on historical reasons. Such a signal definition is well known in consumer applications like remote controls.<br><br>We accept a variation of the carrier frequency of about ±2kHz during the Homologation tests. |
| Duty Cycle | Duty cycle is first independent of the chosen frequency.<br>We make demands on the 50% duty cycle in view of laser safety reasons (necessary for the classification process). |
| Parameter tolerances | If we get a deviation of 3% on the frequency fc , we get the corresponding deviation in the number of pulses. If the time duration of an individual code structure will be changed by 3% we get of course the corresponding 3% deviation in the number of pulses therewith.<br><br>The number of pulses is a result of a calculation with the main parameters! Particularly in the case that we get a deviation of the frequency and of the timing specification simultaneously, we need an overall specification. That is why we have specified the so-called 80%-definition. |

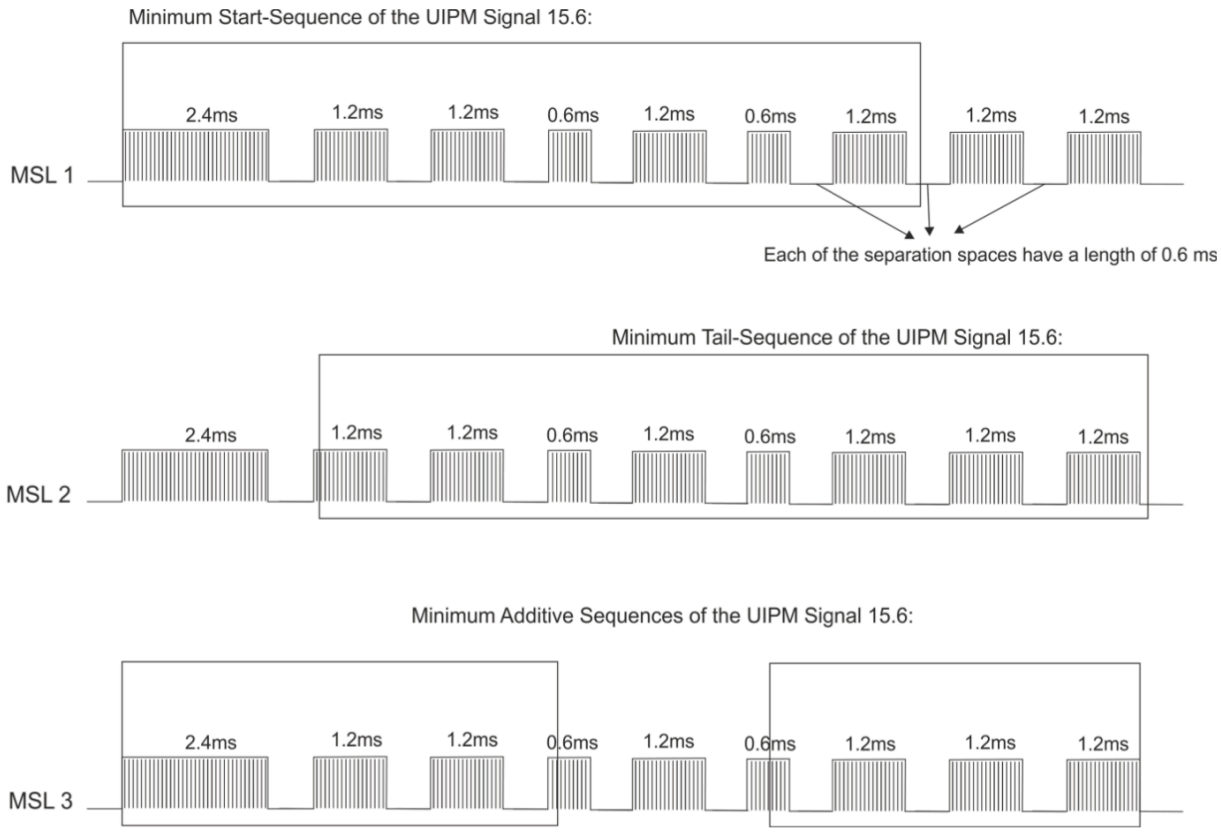
| | |
|---|---|
| **UIPM Signal_15.6**<br>total length:<br>15.6ms<br>Used signal components:<br>The start-sequence, logical 'one' and logical 'zero' as defined above. |  <br>To register a Hit:<br>Movement-effects and raindrops interfere the laser signal received by the target. As an effect of this, some parts of the signal train may be missing. Therefore a Hit is to be registered if a minimum of 80% of the UIPM Signal_15.6 was present. |
| **UIPM signal 15.6/Sighting**<br>Pulse train repetition frequency<br>PtRF ≤ 3.7 |  <br>For sighting the UIPM signal 15.6 should also be used. In this mode **(check the currently valid regulations)** the pistol should fire automatically every 250ms. This is in view of the laser safety aspect. This signal/timing is a possible replacement of the constant beam signal. |

**Pulse train Repetition Frequency (PtRF)**
The Repetition Frequency PtRF has been designed according to the specification of the UIPM Signal_15.6 and on the laser safety parameters.

# The 80% Characterization (Parameter Value variation for target tests)

The 80% value characterizes an overall valuation like a cross-correlation function. In view of that, we have to define a correct UIPM Laser signal including some tolerances which in turn consider possible interferences like light effects, rain and code disturbance.

If 80% or more of the signal shape (signal code) will be detected, the signal has to be accepted as a correct UIPM signal and shall cause a “hit” indication.




Sketch: Definition of so-called Minimum Sequence Lengths: MSL1, MSL2, MSL3 ≥ 12,48ms which are used for various tests. Only the parts of the signal which are inside the rectangles which were drawn over the signal shape will be received by the target electronic.

**<u>Variation on individual Signal parameters:</u>**

| | |
|---|---|
| Total Signal length | ≥ 12,48ms, max. 15.6ms + 3% |
| start sequence | 2,4ms ± 3% |
| Logical “1”, “0” and “Pause” | 1,2ms ± 3%, 0.6ms ± 3% and 0.6ms ± 3% |
| Carrier frequency (fc) | 40kHz ± 3% |
| | |

## Homologation Tests specification

**Important Remark**
In view of the so-called "First Impact Detection" scheme, the 80% parameter test will be useful only in view of the simple HIT-Target.
Concerning the PLT Target and the Hit&Miss Target, only the parameter "First Impact Detection" is tested during the Homologation procedure.

| **Explanation of the 80% in respect to the signal duration:** | **Inspected parameter** | **Explanation** |
|---|---|---|
| If the received/detected signal is shorter than **the Min-Value**=12,48ms (80% of the 15.6ms), the signal shall not be registered as a valid UIPM signal and it should be no indication of a "hit" or "miss".<br>**Time period inspection** | Check of the start sequence, min/max value and tests with the M1, M2, M3 sequences | The target electronic has to decide whether the signal was valid or not valid. |
| **Signal characterization** | signal shape/code, signal modulation frequency and signal duration | **E**xample: raindrops interfere the signal<br>A correlation process (comparison of the actual signal with the expected signal shape) will be used to decide whether a correct UIPM Laser signal was detected or whether another foreign signal was detected. |

## UIPM Laser Signal and Peak Power Values

Laser safety can't be freely chosen. If we define signal parameters, the classification process at the end assigns the Laser to a certain Laser Class. UIPM has announced **Laser class 1** for the dedicated sport application.

If we get some changes within a new definition/new version of the international norm IEC 60825/EN 60825, UIPM will adjust the proposed parameters in the same way (extend or reduce the peak values).

| **Signal Specification** | **15,6ms** | **comment** |
|---|---|---|
| **Max. peak power***[1] | 3.4 mW | Laser class 1 |
| **Min. Laser peak power***[2] | 2.5 mW | in respect to the sensitivity of the targets (Hit&Miss/PLT) |
| **UIPM signal 15.6/Sighting**<br>**PtRF ≤ 3.7,** max. peak power | 3.4 mW | |
| **Duty Cycle** | **50%** | for Laser class 1 |

Changing the signal parameters will cause that new peak power values obtained!
C6 = 1 (beam divergence ≤ 1.5 mrad)

*[1]A manufacturer's certificate confirms to the UIPM compliance of all components with the IEC 60825-1:2014 V3 and all updates.
*[2] Ambient light like sunlight or artificial light could influence the detection performance of the targets. Therefore, the minimum peak power was defined and the direct ambient light (without the shot signal) onto the surface of the detection area should not exceed 30klx.

2 - O laser deve ser na cor VERMELHO;

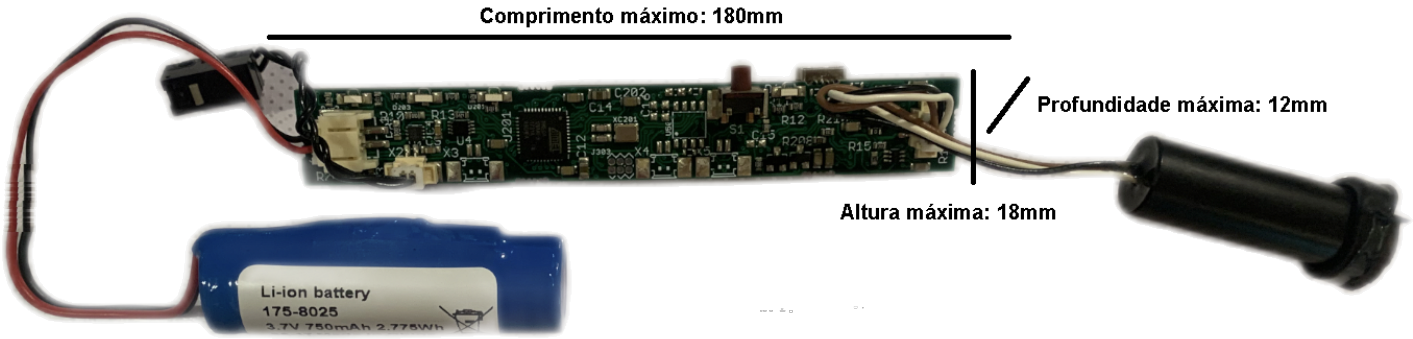
3 - O laser deve levar ser disparado 6ms após o microswitch ser acionado;

4 - O laser deve atender às especificações de segurança internacionais para “Laser Class 1” ((EN 60825-1:2014/IEC 60825-1:2014);

5 - O diâmetro máximo do feixe laser deve ser de 6mm a 10m de distância;

6 - É aceitável adicionar um colimador ao diodo laser;

7 - A placa com todo sistema deve caber em uma caixa de no máximo 18mm de altura, por 180mm de comprimento, por 12mm de profundidade:




# TAREFA 4

Fazer todos os ajustes necessários e modificações para que o projeto funcione perfeitamente. Esta tarefa corresponde a 5% do projeto.