Procedure to Test LEDs' Range

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I. Introduction

A. Purpose

This document describes the procedure to test the range of LEDs to use in a position and anti-collision lights system for small unmanned aircraft (sUA).

B. System Overview

The system is composed by two subsystems: the Position lights system and the Anti-collision lights system. The position lights subsystem has a red light positioned on the left side of the aircraft, a green light on the right side and a white light mounted as far back as possible. The anti-collision lights subsystem must have one or more red or white lights with a flashing frequency between 40 and 100 cycles per minute. A block diagram of the system is shown in figure 1.

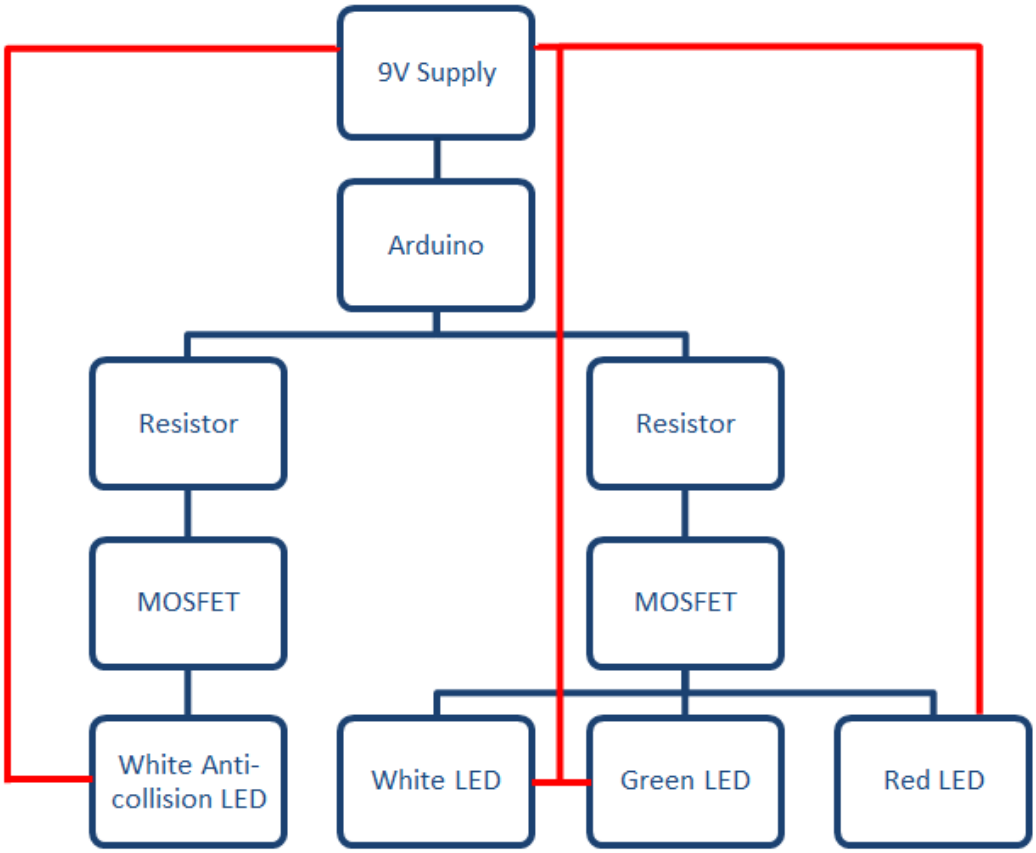

Figure 1. Block diagram of Position and Anti-Collision Lights System

C. System Release Description

All lights will be tested without any aircraft present, according to figures 2, 3, 4 and 5.
The Green, Red and White LEDs have a viewing angle as depicted in figure 6.
The Anti-collision LED has a viewing angle as depicted in figure 7.

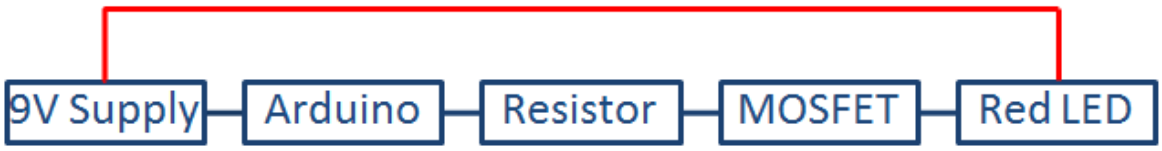

Figure 2. Block diagram for the Red LED test

Figure 3. Block diagram for the Green LED test

Figure 4. Block diagram for the White LED test

Figure 5. Block diagram for the Anti-Collision White LED test

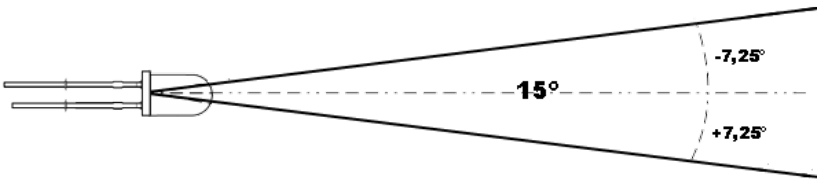

Figure 6. Green, Red and White LEDs' viewing angle

D. Test Approach Description

To evaluate the range of the LEDs a test will be performed which consists in obtaining an evaluation of visibility of the LEDs by 30 individuals. Half the individuals will start the test at 50 m at move towards the 350 m mark, while the other half will start the test at 350 m and move towards the equipment.

II. Test Procedures

For the test procedure, the system should be connected according to figure 8 and 9, with program 'LED test', loaded into the Arduino™memory.

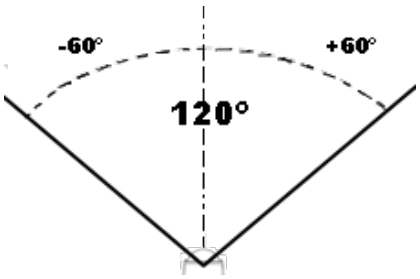

Figure 7. Anti-collision LED's viewing angle

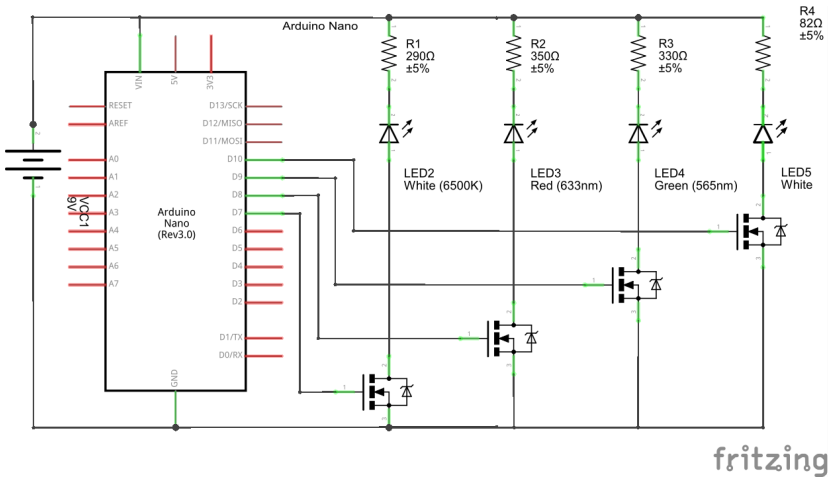

Figure 8. Block diagram for the test procedure

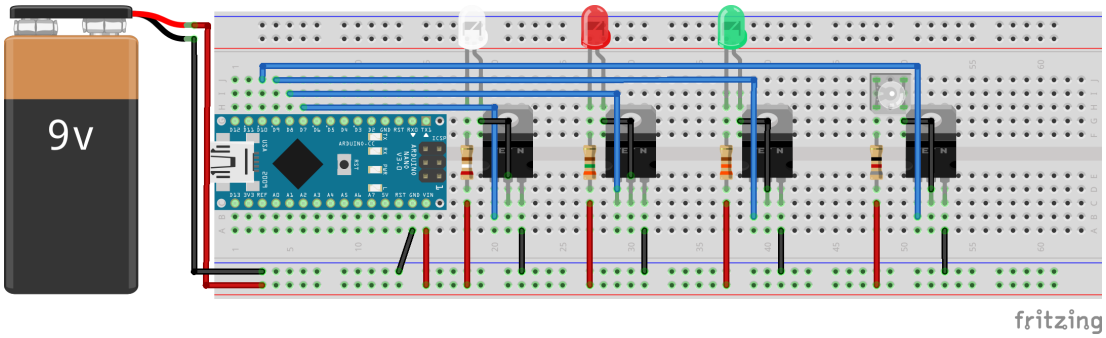

Figure 9. Diagram for the test procedure

The system shall be mounted on a tripod to enable aiming it.
The system shall stay in the same position, with the observer moving.

A. *Requirements Testing*

1) Test Approach: The system must be positioned as showed in figure 10. The observer will start in the 50 or 350 meters marks and will evaluate the visibility of all LEDs. The procedure will then be repeated for the remaining marks (100, 150, 200, 250 and 300).

2) Equipment Needed:

- Arduino Nano 3.0 (x1)
- Connection cables
- DC Power Supply AimTTi EL183R (x1)
- Breadboard (x1)
- 5mm Super Bright Green LED – 5A3 Series (Angle 25deg, Luminous intensity 18000 mcd, Forward voltage 3.1V, Forward current 20mA, Power dissipation 100mW) (x1)

Figure 10. System position and different ranges (50, 100, 150, 200, 250, 300 and 350m)

- 5mm Super Bright Red LED – 5A3 Series (Angle 25deg, Luminous intensity 10600 mcd, Forward voltage 2.1V, Forward current 20mA, Power dissipation 100mW) (x1)
- 5mm Super Bright White LED – 5C3 Series (Angle 25deg, Luminous intensity 30000 mcd, Forward voltage 3.2V, Forward current 20mA, Power dissipation 100mW) (x1)
- Super Fllux Pure White LED (Angle 120deg, Luminous intensity 12000 mcd, Forward voltage 3.1V, Forward current 90mA, Power dissipation 324mW) (x1)
- Tripod (x1)
- 82Ω 1/2W Resistor (x1)
- 290Ω 1/4W Resistor (x1)
- 330Ω 1/4W Resistor (x1)
- 350Ω 1/2W Resistor (x1)
- 10kΩ 1/4W Resistor (x1)
- N-Channel Power MOSFET STP55NF06 (x4)

B. Test Reporting Requirements

The test will provide visibility results, with variable range. The individuals will provide a quantitative appreciation from 0 to 10 of the visibility of the different signals.

No test anomalies are expected.

C. Test Case 1

Range test with individuals starting at the 50 meters mark during daytime will follow the procedure in table I.

Table I
PROCEDURE FOR LEDS' RANGE TEST WITH INDIVIDUALS STARTING AT THE 50 METERS MARK

Step	Procedure	Expected Result	Pass/Fail			
			G	R	W	A
1	Turn system on	LED on				
2	Move the individual to the 50m mark	-				
3	Tell individual the answer should be a value between 0 and 10	-				
4	Ask the individual for his value	9-10				
5	Move the individual to the 100m mark	-				
6	Ask the individual for his value	9-10				
7	Move the individual to the 150m mark	-				
8	Ask the individual for his value	8-10				
9	Move the individual to the 200m mark	-				
10	Ask the individual for his value	8-10				
11	Move the individual to the 250m mark	-				
12	Ask the individual for his value	7-10				
13	Move the individual to the 300m mark	-				
14	Ask the individual for his value	6-10				
15	Move the individual to the 350m mark	-				
16	Ask the individual for his value	5-10				
17	Turn all systems off	All systems off				

Perform for each individual.

D. Test Case 2

Range test with individuals starting at the 350 meters mark during daytime will follow the procedure in table II.
Perform for each individual.

Table II
PROCEDURE FOR LEDS' RANGE TEST WITH INDIVIDUALS STARTING AT THE 350 METERS MARK

Step	Procedure	Expected Result	Pass/Fail			
			G	R	W	A
1	Turn system on	LED on				
2	Move the individual to the 350m mark	-				
3	Tell individual the answer should be a value between 0 and 10	-				
4	Ask the individual for his value	9-10				
5	Move the individual to the 300m mark	-				
6	Ask the individual for his value	9-10				
7	Move the individual to the 250m mark	-				
8	Ask the individual for his value	8-10				
9	Move the individual to the 200m mark	-				
10	Ask the individual for his value	8-10				
11	Move the individual to the 150m mark	-				
12	Ask the individual for his value	7-10				
13	Move the individual to the 100m mark	-				
14	Ask the individual for his value	6-10				
15	Move the individual to the 50m mark	-				
16	Ask the individual for his value	5-10				
17	Turn all systems off	All systems off				