Procedure to Test IR Anti-Collision System's Range

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I. Introduction

A. Purpose

This document describes the procedure to test the range and angular coverage of a IR anti-collision system for small RPAS.

B. System Overview

The system is composed by a transmitting and a receiving subsystems. The transmitting subsystem uses several IR LEDs controlled by an Arduino to send the sector information. The other subsystem uses several IR detectors to receive the sent data and an approximate transmitter's direction. A block diagram of the system is shown in figure 1.

Figure 1. Block diagram of the IR Anti-Collision System

C. System Release Description

The two subsystems will be used separately in the test, without any aircraft present, according to figure 2.

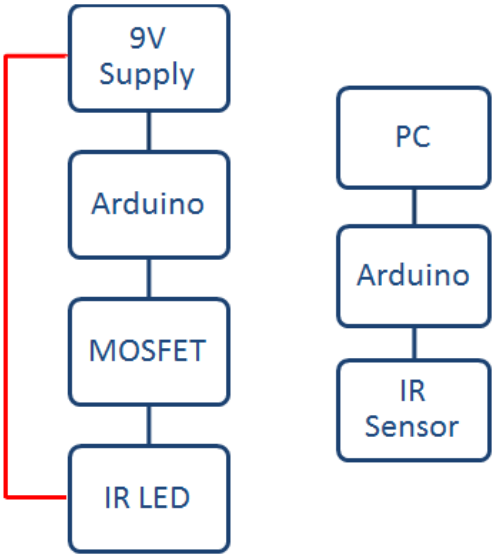

Figure 2. Block diagram of the IR Anti-Collision Subsystems for the Test

The IR LED has a radiation angle as depicted in figure 3.

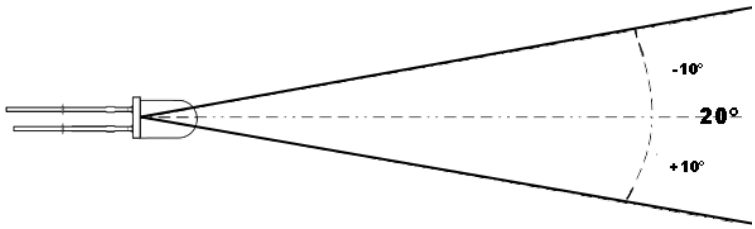

Figure 3. IR LED's radiation angle

The IR Receiver's angle of half transmission distance is equal to $\pm 45^{o}$ as depicted in figure 4.

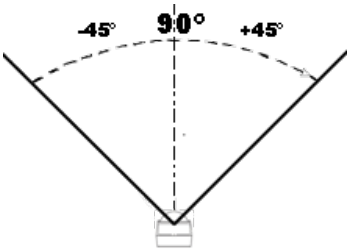

Figure 4. IR Receiver's angle of half transmission distance

D. Test Approach Description

To test the range and angular coverage of the system, several signals will be transmitted between the subsystems. The test will be executed during day and night time.

II. Test Procedures

To test the system, the transmitting subsystem shall be connected according to figures 5 and 6, with program 'TesteIRsender.ino', loaded into the Arduino memory.

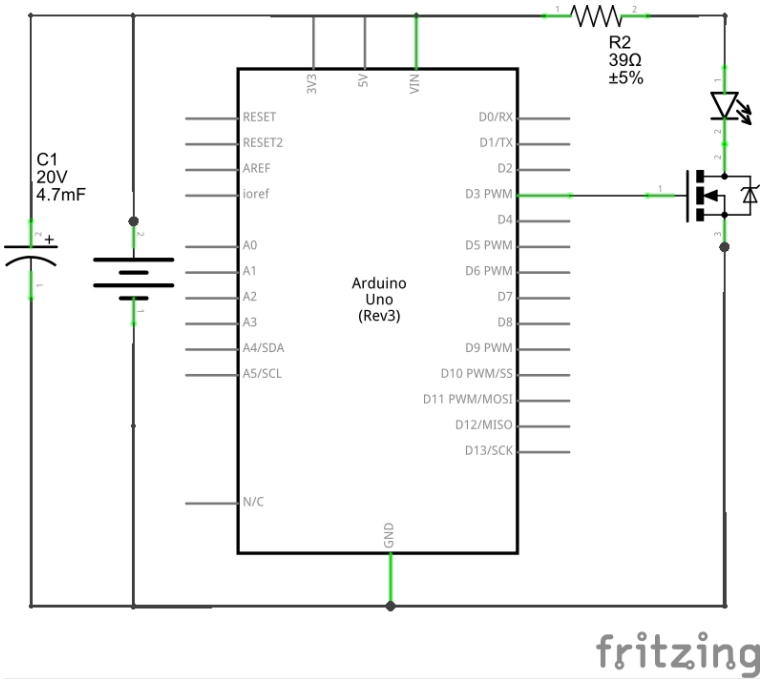

Figure 5. Block diagram for the transmitting subsystem

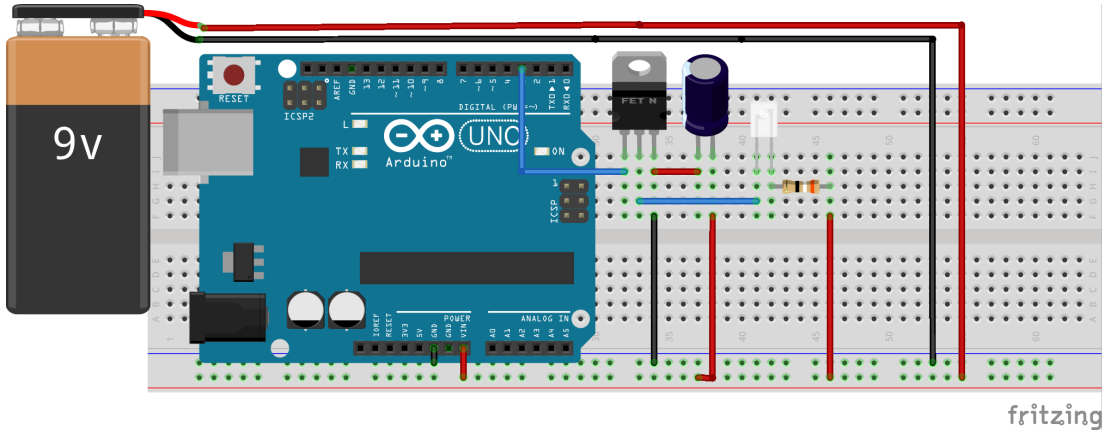

Figure 6. Diagram for the transmitting subsystem

The signal will be coded using the RC-5 protocol which, as can be seen in figure 7, uses bi-phase modulation (or Manchester code) and is composed by:

- two start bits always set to 1
- a toggle bit which will always be set to 0 for this test
- five bits to represent the IR device address, set to 14 for this test
- 6 bit command (’0’, ’1’ or ’2’)

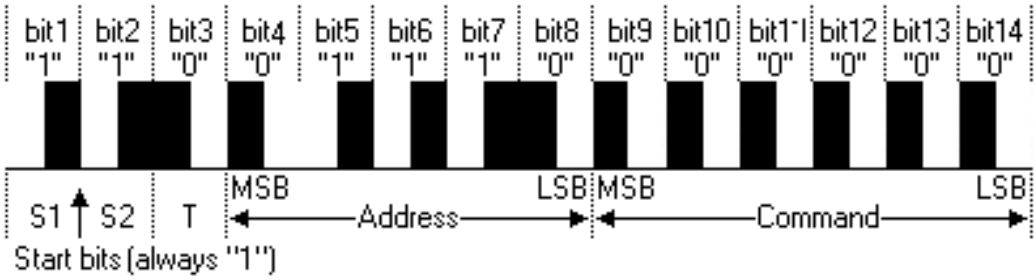

Figure 7. RC-5 coded signal

Instead of using a 36kHz carrier frequency, 56kHz will be used.

The receiving subsystem shall be connected according to figures 8 and 9, with program ’TesteIRreceiver.ino’ loaded into the Arduino memory.

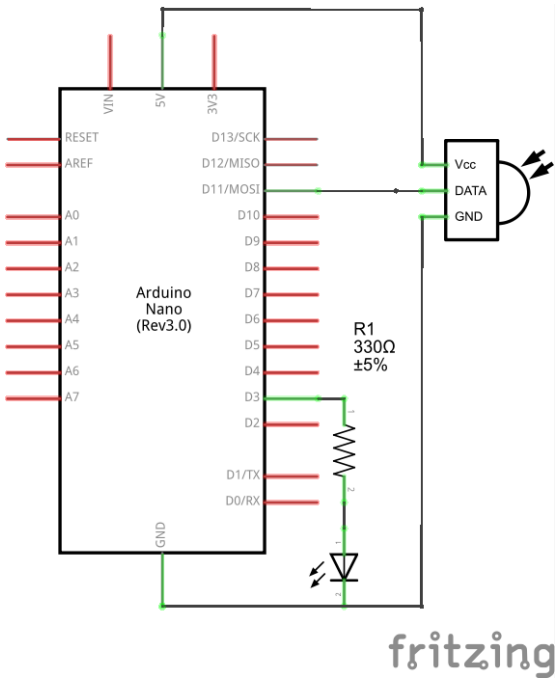

Figure 8. Block diagram for the receiving subsystem

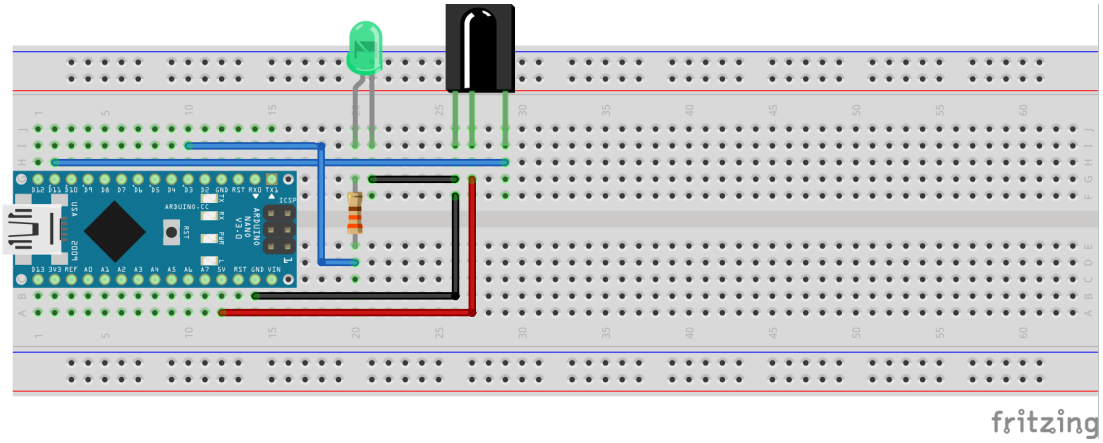

Figure 9. Diagram for the receiving subsystem

Both subsystems shall be mounted on a tripod, the transmitting one with a laser attached to enable aiming it, as represented in figures 10 and 11.

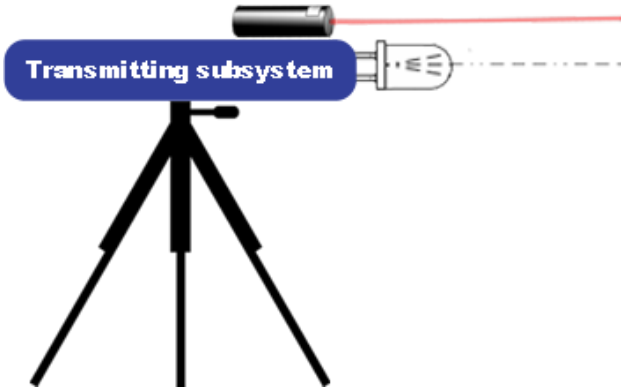

Figure 10. Transmitting subsystem mount

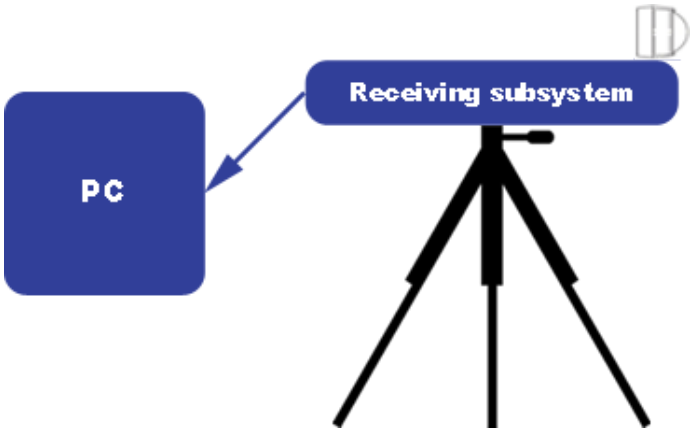

Figure 11. Receiving subsystem mount

To reduce the amount of noise introduced by the sun into the system, a cylinder shall be used as a filter, mounted with the transmitter and receiver inside, as represented in figures 12 and 13.

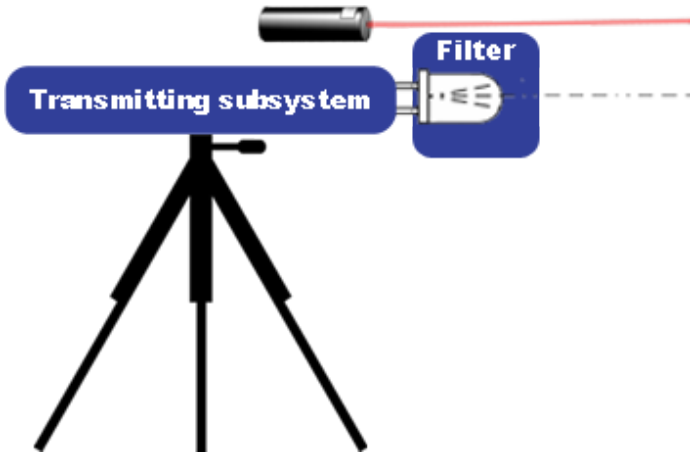

Figure 12. Transmitting subsystem mount with filter

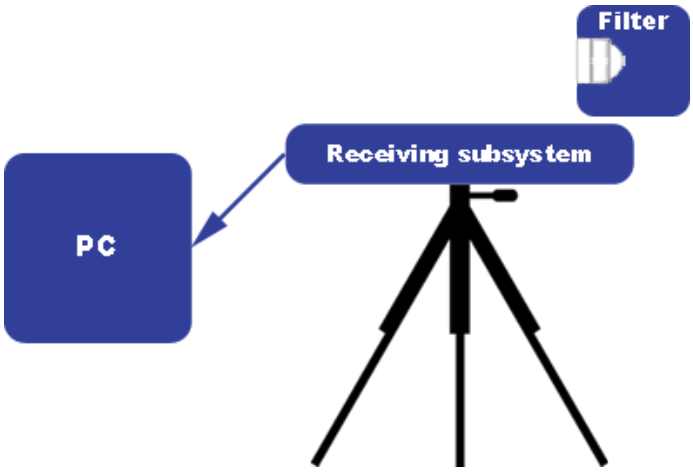

Figure 13. Receiving subsystem mount with filter

A. Requirements Testing

1) Test Approach: To test the range, the transmitting subsystem must be positioned as showed in figure 14. The receiver will then be placed in the 2 meters mark and the operator should check if the signal is received. If it is, the operator shall move the receiver in the direction of the other marks, perpendicular to the transmitter, until the maximum range. With the receiver in this position, to test the angular coverage, the transmitter shall rotate until the signal is no longer received.

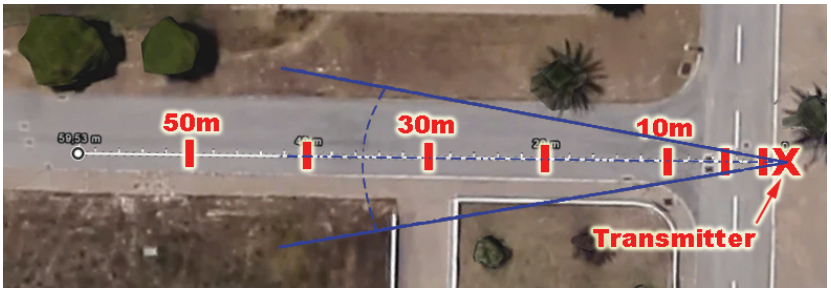

Figure 14. Transmitter position and different ranges (2, 5, 10, 20, 30, 40 and 50m)

2) Equipment Needed:

- Arduino Nano 3.0 (x1)
- Arduino Uno R2 (x)
- Connection cables
- DC Power Supply AimTTi EL183R (x1)
- Breadboard (x2)
- 5mm Super Bright Green LED – 5A3 Series (Angle 15deg, Luminous intensity 18000 mcd, Forward voltage 3.1V, Forward current 20mA, Power dissipation 100mW) (x1)
- High Power Infrared Emitting Diode 940 nm (Angle 20deg, Radiant intensity 170mW/sr, Forward voltage 1.35V, Forward current 100mA, Power dissipation 40mW) (x1)
- IR Receiver TSOP4856 56khz (Angle 90deg, Minimum irradiance 0.12W/m^2, Maximum irradiance 50W/m^2) (x1)
- Laser (x1)
- Protractor (x1)
- Tripod (x2)
- 330Ω 1/4W Resistor (x1)
- 39Ω 1/2W Resistor (x1)
- N-channel 60V Power MOSFET TO-220 STP55NF06 (x1)
- Cardboard cylinder (x2)

B. Test Reporting Requirements

The tests will provide an approximate range from both the transmitter and the receiver.
No test anomalies are expected.

C. Test Case 1

Range and angular test with receiver and transmitter during daytime will follow the procedure in table I using figure 14 setup, with the systems mounted as represented in figures 10 and 11.

Table I
PROCEDURE FOR TRANSMITTER RANGE AND ANGULAR TEST DURING DAYTIME

Step	Procedure	Expected Result	Pass/Fail
1	Place receiver at the 2m mark	-	
2	Turn receiver on	Receiver on	
3	Aim transmitter at the receiver	Laser pointing at receiver	
4	Check PC for incoming data	Signal received in PC	
5	Move receiver toward 50m mark	Signal received in PC	
6	Stop at the signal's maximum range	Maximum range acquired	
7	Slowly rotate transmitter	Receiver's LED on	
8	Stop when the LED turns off	Receiver's LED off	
9	Measure angle with protractor	Angular coverage acquired	
10	Turn all systems off	All systems off	

D. Test Case 2

Range and angular test with receiver and filtered transmitter during daytime will follow the procedure in table II using figure 14 setup, with the systems mounted as represented in figures 12 and 11.

Table II
PROCEDURE FOR FILTERED TRANSMITTER RANGE AND ANGULAR TEST DURING DAYTIME

Step	Procedure	Expected Result	Pass/Fail
1	Place receiver at the 2m mark	-	
2	Turn receiver on	Receiver on	
3	Aim transmitter at the receiver	Laser pointing at receiver	
4	Check PC for incoming data	Signal received in PC	
5	Move receiver toward 50m mark	Signal received in PC	
6	Stop at the signal's maximum range	Maximum range acquired	
7	Slowly rotate transmitter	Receiver's LED on	
8	Stop when the LED turns off	Receiver's LED off	
9	Measure angle with protractor	Angular coverage acquired	
10	Turn all systems off	All systems off	

E. Test Case 3

Range and angular test with filtered receiver and filtered transmitter during daytime will follow the procedure in table III using figure 14 setup, with the systems mounted as represented in figures 12 and 13.

Table III
PROCEDURE FOR FILTERED TRANSMITTER RANGE AND ANGULAR TEST DURING DAYTIME WITH FILTERED RECEIVER

Step	Procedure	Expected Result	Pass/Fail
1	Place receiver at the 2m mark	-	
2	Turn receiver on	Receiver on	
3	Aim transmitter at the receiver	Laser pointing at receiver	
4	Check PC for incoming data	Signal received in PC	
5	Move receiver toward 50m mark	Signal received in PC	
6	Stop at the signal's maximum range	Maximum range acquired	
7	Slowly rotate transmitter	Receiver's LED on	
8	Stop when the LED turns off	Receiver's LED off	
9	Measure angle with protractor	Angular coverage acquired	
10	Turn all systems off	All systems off	

F. Test Case 4

Range and angular test with transmitter and filtered receiver during daytime will follow the procedure in table IV using figure 14 setup, with the systems mounted as represented in figures 10 and 13.

Table IV
PROCEDURE FOR TRANSMITTER RANGE AND ANGULAR TEST DURING DAYTIME WITH FILTERED RECEIVER

Step	Procedure	Expected Result	Pass/Fail
1	Place receiver at the 2m mark	-	
2	Turn receiver on	Receiver on	
3	Aim transmitter at the receiver	Laser pointing at receiver	
4	Check PC for incoming data	Signal received in PC	
5	Move receiver toward 50m mark	Signal received in PC	
6	Stop at the signal's maximum range	Maximum range acquired	
7	Slowly rotate transmitter	Receiver's LED on	
8	Stop when the LED turns off	Receiver's LED off	
9	Measure angle with protractor	Angular coverage acquired	
10	Turn all systems off	All systems off	

G. Test Case 5

Range and angular test with receiver and transmitter during nighttime will follow the procedure in table V using figure 14 setup, with the systems mounted as represented in figures 10 and 11.

Table V
PROCEDURE FOR TRANSMITTER RANGE AND ANGULAR TEST DURING NIGHTTIME

Step	Procedure	Expected Result	Pass/Fail
1	Place receiver at the 2m mark	-	
2	Turn receiver on	Receiver on	
3	Aim transmitter at the receiver	Laser pointing at receiver	
4	Check PC for incoming data	Signal received in PC	
5	Move receiver toward 50m mark	Signal received in PC	
6	Stop at the signal's maximum range	Maximum range acquired	
7	Slowly rotate transmitter	Receiver's LED on	
8	Stop when the LED turns off	Receiver's LED off	
9	Measure angle with protractor	Angular coverage acquired	
10	Turn all systems off	All systems off	