Gary Stevens
10/7/18

Wing Aerodynamics for Minimum Weight Configuration

These calculations are for the minimum weight configuration of 8.944 pounds RTF. This is without the optional telemetry system (6.0oz) and without a second 2S3.3AH LiPO battery and cable (7.5oz). This saves 13.5oz (0.844_lb).

Useful wing area: 12.4" chord x (120"-4"fuse-4"skids) = 12.4 x 112" = 1388.8 sq-in. wetted (0.8960m^2)
Reynolds number is approx 250k for 12.4" chord and ~24.59MPH
From Airtools.com for Clark YH airfoil, and ajtoold.com for lift calculations:
http://www.ajdesigner.com/phpwinglift/wing_lift_equation_surface_velocity.php

Alpha	Cl	Cd	L/D	Velocity to lift 8.944_lb (MPH)	(m/s)	
-3	0	.02	0	infinite		
0	.4	.02	20	30.11	1346	
1	.5	.017	34	26.94	12.04	
2	.6	.015	40	24.59	10.99	<-- Operate here at 2 degree AOA at ~24.59MPH
3	.7	.016	42	22.76	10.18	
4	.8	.018	44	21.29	9.52	
5	.9	.019	46	20.08	8.97	
6	.95	.02	47	19.54	8.74	
7	1.07	.021	51	18.41	8.23	
8	1.10	.023	48	18.16	8.12	Near stall AOA! 18.41MPH

Airspeed Equations from AJDesigner.com

Lift (in Newtons) = 1/2 (Cl * Air Density(in Kg/Cu-M) * V(M/s)^2 * Area(sq-meters)
where Air density is 1.225kg/M^3
and:
Velocity in meters per second = SQRT [(2 * Lift in Newtons)/(Cl * Air density in Kg/ M^3 * Area in sq meters)]

Finite Aspect Ratio Lift Over Drag

Cd = Cd(zero lift) + [Cl^2 / (3.1415 * Aspect Ratio * e)]
For rectangular wing, e=0.70 per https://www.grc.nasa.gov/www/k-12/airplane/induced.html
From airtools.com, pick airfoil and then find its Cd(zero lift) and its Cl at the operating angle of attack.
For the Clark-YH airfoil, Cd(zero lift) is .012 and Cl = .6 at 2 degrees AOA.
Aspect Ratio is 120"/12.4" = 9.68
So, Cd(finite aspect ratio) = .012 + (.6^2 / (3.1415 * 9.68 * 0.7) = .012 + 0.0169 = .0289
Now compute the actual wing's Lift / Drag:
Cl /Cd(finite span) = .6 / .0289 = 20.76 = The Wing's Finite-Span Lift/Drag Ratio

Wing Drag (in Newtons) = 1/2 (Cdfar * Air Density(in Kg/Cu-M) * V(M/s)^2 * Area(sq-meters)
= .5 (.0289 * 1.225 * 11.14 * 11.14 * 0.896) = 1.968N
Wing Drag = 1.968N = 0.442 pounds-force for finite span wing at 24.59MPH