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Performance Comparison

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Test setup

Motor: Tiger Motor MT2216 V2.0 KV: 1100
ESC: Emax BLHELI 30A

Test tool: RCbenchmark dynamometer Series 1580
Serial number: FCFD9E170000BC
Gui version: 0.96.6
Firmware version: 1.15 (Updated)

Propellers under comparison:

- Master Airscrew MR 9X4.5” R
- APC C-2 9x4.5” MRP
- Graupner E-Prop 9x5” L

Test configuration:

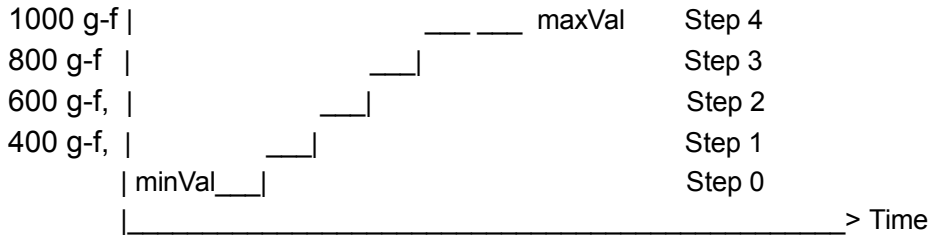
- All tests were done in a controlled environment with no moving air.
- Motor rotation was in the direction of the leading edge.
- Propeller mounting was in pusher configuration,
  (Air flow was in the opposite direction from the testing tool
  i.e away from the sensors.)

Test 1 : Parameter testing

➔ **Test range:** *Client specified thrust ranges*

➔ **Testing script details:** *PID control loop to lock at specific steps (Specified thrust levels)*

Motor Input



❑ **Average Samples taken = 50**;
// how many samples to average before recording the data point (after system stable)

❑ **Integration Constant = 0.04**;
// how fast to integrate towards goal thrust (increase if too slow, decrease if oscillations)

❑ **Tolerance = 0.025**;
// Thrust that the system can assume stable (note that 1uS ESC output resolution may cause thrust to oscillate within this value this is totally normal and unavoidable)

❑ **Maximum throttle rate = 20 us/sec** rate for the ramp towards target thrust

❑ **Minimum throttle rate = 5 us/sec** min rate towards goal

❑ **Advance thrust = 0.03 kg-f ;**
// when ramping, will stop in advance (before target) to minimize overshoot due to system/ESC delays and inertia.

- **Number of sign changes allowed= 5;**
  // system considered stable when sign changes this many times while within tolerance. This method is effective because it ensures the system is not within tolerance but still converging to setpoint: it has to oscillate around the setpoint.

Script name:
R68550_452(WP).js

TEST REMARKS

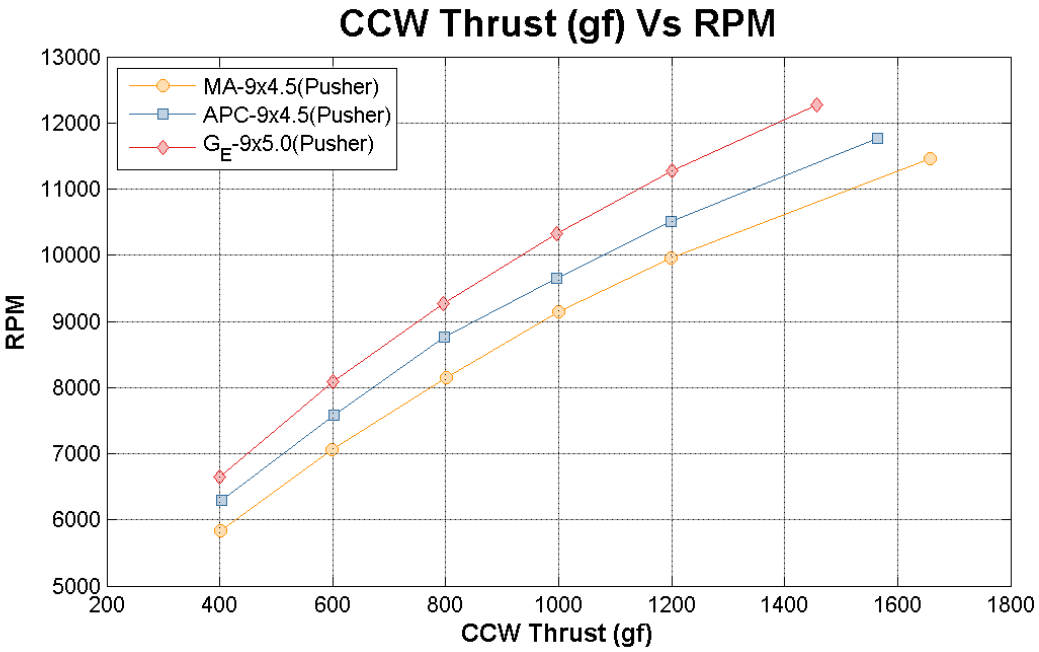
For the original CSV data, please see the files attached with the report.

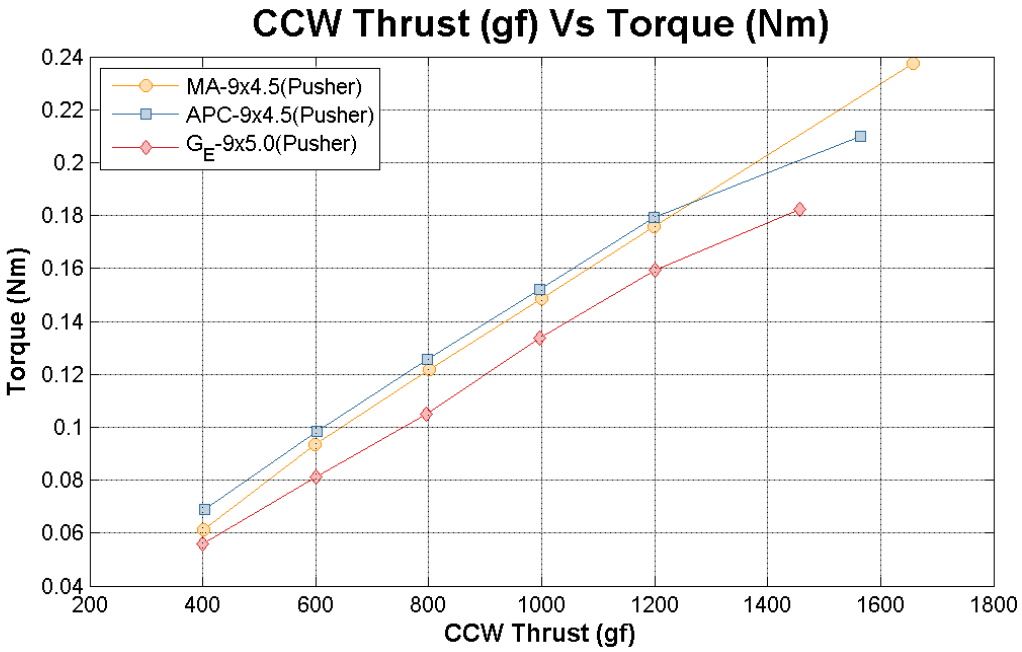
- **Master Airscrew MR 9X4.5" R**
  1. Rotation set to anticlockwise to match pusher configuration
  2. Torque sign checked
  3. All the thrust ranges were matched

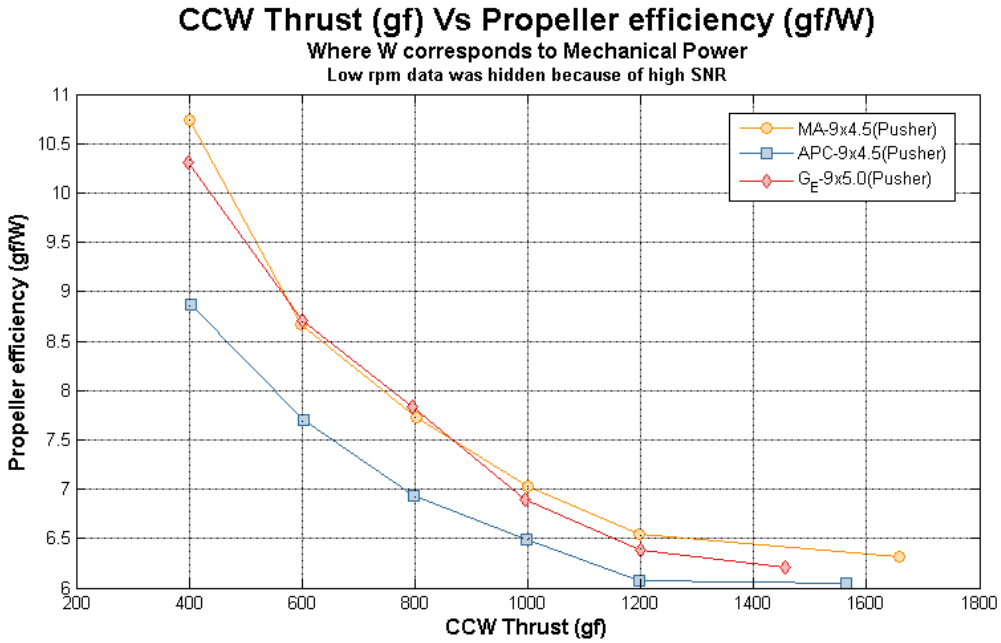
- **APC C-2 9x4.5" MRP**
  1. Rotation set to anticlockwise to match pusher configuration
  2. Torque sign checked
  3. All the thrust ranges were matched

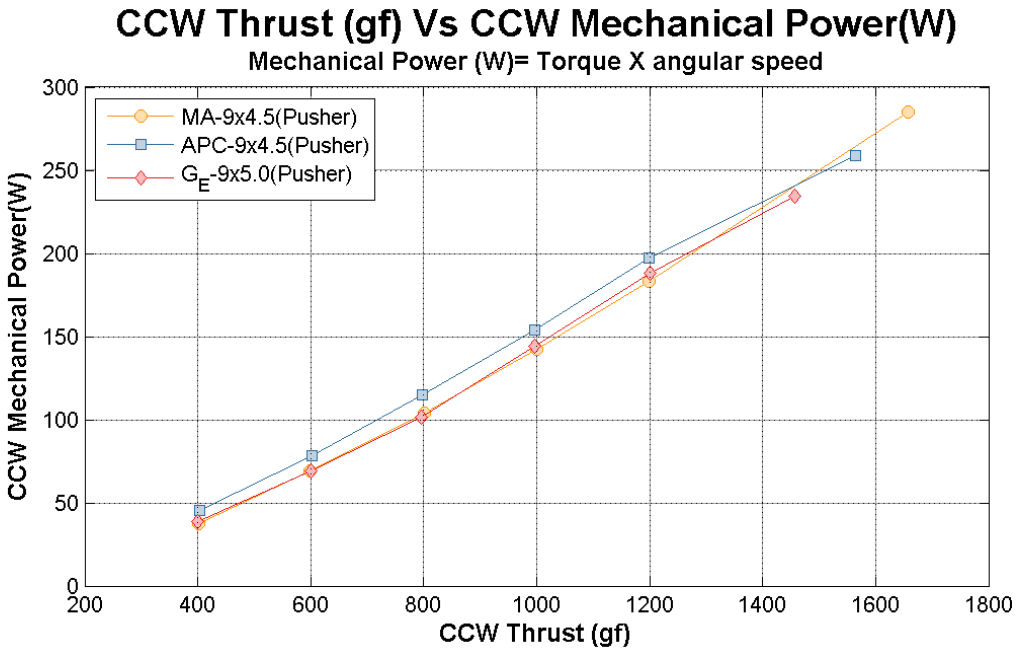
- **Graupner E-Prop 9x5" L**
  1. Rotation set to anticlockwise to match pusher configuration
  2. Torque sign checked
  3. All the thrust ranges were matched

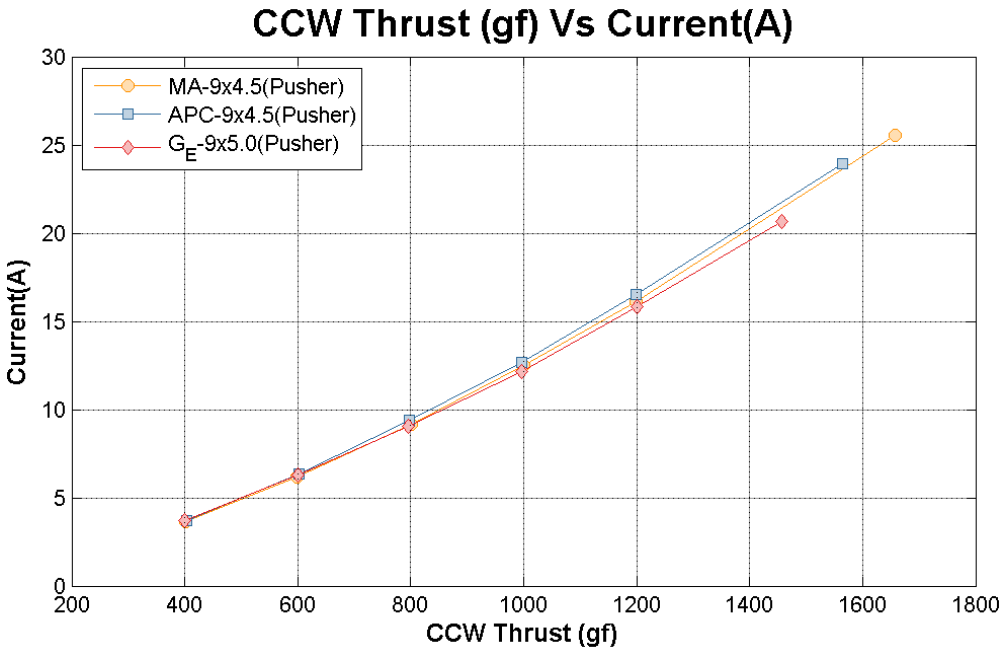
TEST PLOTS

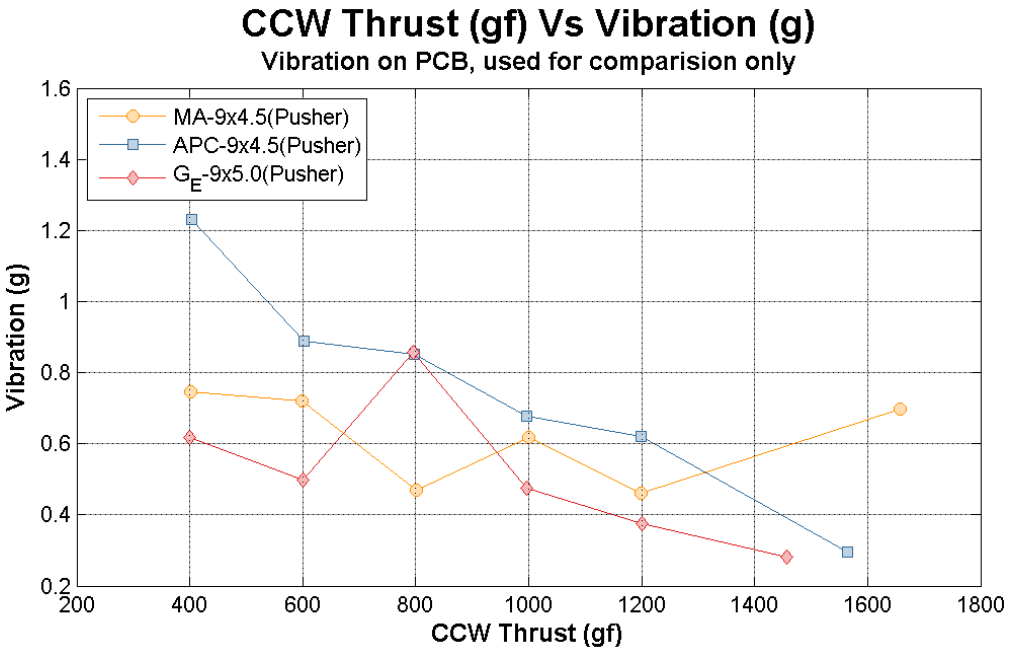

CCW Thrust (gf) Vs RPM
MA-9x4.5(Pusher)
APC-9x4.5(Pusher)
G_E-9x5.0(Pusher)
RPM
CCW Thrust (gf)
13000
12000
11000
10000
9000
8000
7000
6000
5000
200
400
600
800
1000
1200
1400
1600
1800


CCW Thrust (gf) Vs Torque (Nm)
MA-9x4.5(Pusher)
APC-9x4.5(Pusher)
G_E-9x5.0(Pusher)
Torque (Nm)
CCW Thrust (gf)
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
200
400
600
800
1000
1200
1400
1600
1800


CCW Thrust (gf) Vs Propeller efficiency (gf/W)
Where W corresponds to Mechanical Power
Low rpm data was hidden because of high SNR
Propeller efficiency (gf/W)
CCW Thrust (gf)
MA-9x4.5(Pusher)
APC-9x4.5(Pusher)
G_E-9x5.0(Pusher)
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
200
400
600
800
1000
1200
1400
1600
1800


CCW Thrust (gf) Vs CCW Mechanical Power(W)
Mechanical Power (W)= Torque X angular speed
CCW Mechanical Power(W)
CCW Thrust (gf)
MA-9x4.5(Pusher)
APC-9x4.5(Pusher)
G_E-9x5.0(Pusher)
300
250
200
150
100
50
0
200
400
600
800
1000
1200
1400
1600
1800

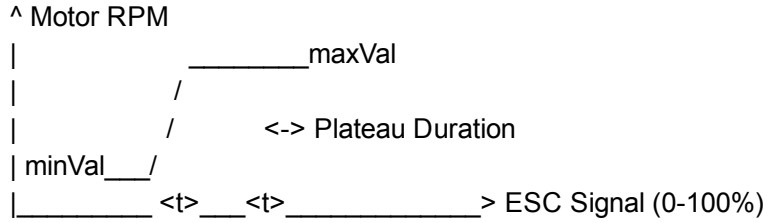

CCW Thrust (gf) Vs Current(A)
MA-9x4.5(Pusher)
APC-9x4.5(Pusher)
G_E-9x5.0(Pusher)
Current(A)
CCW Thrust (gf)
0
5
10
15
20
25
30
200
400
600
800
1000
1200
1400
1600
1800


CCW Thrust (gf) Vs Vibration (g)
Vibration on PCB, used for comparision only
MA-9x4.5(Pusher)
APC-9x4.5(Pusher)
G_E-9x5.0(Pusher)
Vibration (g)
CCW Thrust (gf)
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
200
400
600
800
1000
1200
1400
1600
1800

Test 2 : RPM test

➔ **Test range:** *0-100% throttle*

➔ **Testing script details:** *Ramp Input from 1000-2000 ESC signal to detect maximum RPM reached by propeller under test*



❑ **var minVal** = 1000;
// Min. input value [700us, 2300us]

❑ **var maxVal** = 2000;
//Max. input value [700us, 2300us]

❑ **var t** = 5;
//Time of the ramp input (seconds)

❑ **var plateauDuration** = 2;
// Time to wait at intial plateau (seconds)

❑ **var plateauUPDuration** = 7;
// Time to wait at maxVal plateau (seconds)

❑ **var samplesAvg** = 20;
// Number of samples taken to average at each reading (reduces noise)

❑ **var rampGoDown** = false;
// Ramp was set to go up only.

Script name:
R68550_RAMP_453(WP).js

TEST REMARKS

For the original CSV data, please see the files attached with the report.

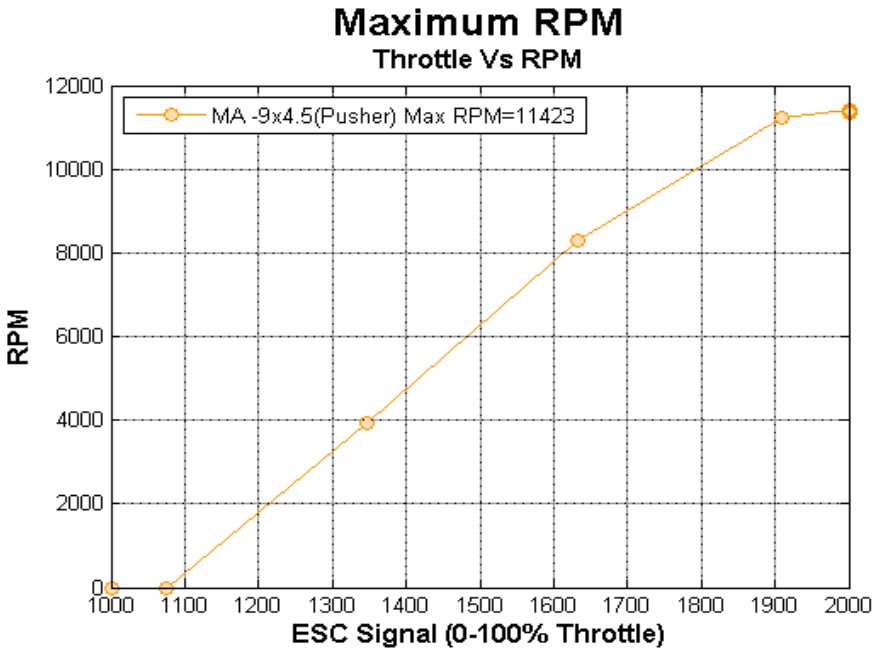
- **Master Airscrew MR 9X4.5" R**
  1. Rotation set to anticlockwise to match pusher configuration
  2. Torque sign checked
  3. 0-100% throttle reached in 20 seconds
  4. Maximum RPM reached by propeller at around 11,400 RPM

- **APC C-2 9x4.5" MRP**
  1. Rotation set to anticlockwise to match pusher configuration
  2. Torque sign checked
  3. 0-100% throttle reached in 20 seconds
  4. Maximum RPM reached by propeller at around 11,600 RPM

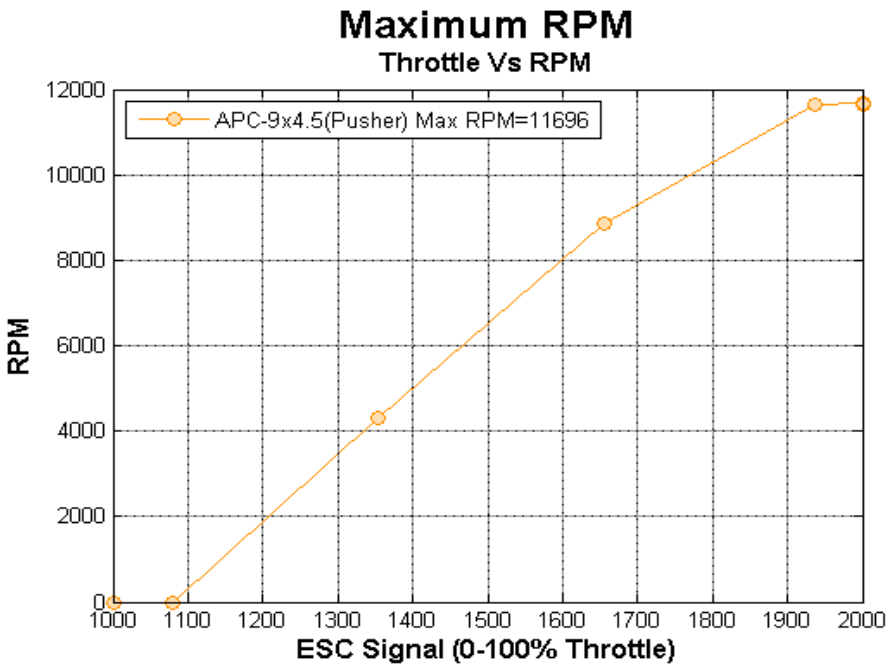
- **Graupner E-Prop 9x5" L**
  1. Rotation set to anticlockwise to match pusher configuration
  2. Torque sign checked
  3. 0-100% throttle reached in 20 seconds
  4. Maximum RPM reached by propeller at around 12,200 RPM

TEST PLOT

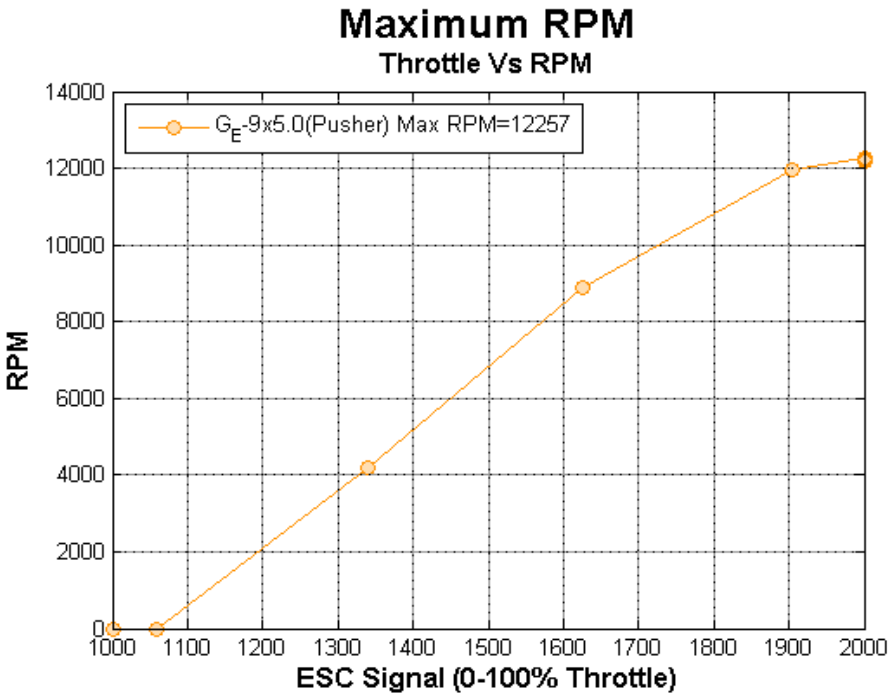
- **Master Airscrew MR 9X4.5" R**



- **APC C-2 9x4.5" MRP**



❖ **Graupner E-Prop 9x5” L**



Plot Comparison