Drone (Multirotor) Hover Power and Flight Time from Battery

Hover power, battery current and flight time of a multirotor drone from its mass, rotors, battery capacity and voltage, by momentum theory with a figure of merit.

Method: Momentum (actuator disc) theory for hover with a figure of merit

Input parameters

Unit system: SI

Parameter	Value	Unit
Take-off mass including battery	1.6000	kg
Number of rotors	4.0000	
Rotor diameter	254.00	mm
Battery capacity	5,000.0	mAh
Battery nominal voltage	14.800	V
Usable fraction of the capacity	80.000	%
Rotor figure of merit	0.65000	
Motor and ESC efficiency	80.000	%
Avionics and payload power	5.0000	W
Altitude (ISA)	0	m

Calculated results

Parameter	Value	Unit
Electrical hover power	174.62	W
Battery current in hover	11.798	A
Hover flight time	20.342	min
Disc loading	77.415	Pa
Power loading (thrust per electrical power)	0.089858	
Usable battery energy	59.200	Wh

Notes for this case

• Ideal hover power per rotor T^1.5/√(2ρA), divided by the figure of merit and the motor–ESC efficiency. Forward flight at moderate speed needs somewhat less power than hover; wind, manoeuvring and cold batteries need more.

Formula and method

$$P_{hover} = \frac{n_r}{FM\,\eta_e}\frac{T^{3/2}}{\sqrt{2\rho A}} + P_{av}, \quad T = \frac{mg}{n_r}, \quad t = \frac{f_u C U}{P_{hover}}$$

Variables

m	Take-off mass including battery	kg
n_r	Number of rotors	-
D	Rotor diameter	m
C	Battery capacity	C
U	Battery nominal voltage	V
f_u	Usable fraction of the capacity	-
FM	Rotor figure of merit	-
η_e	Motor and ESC efficiency	-

P_{av}	Avionics and payload power	W
h	Altitude (ISA)	m
P_{hover}	Electrical hover power	W
I	Battery current in hover	A
t_{flight}	Hover flight time	s
T/A	Disc loading	Pa
mg/P	Power loading (thrust per electrical power)	-
E_{usable}	Usable battery energy	J

Method and standards

Hover momentum theory.

Assumptions and limits

- Steady hover out of ground effect, ISA.

References

Momentum (actuator disc) theory for hover with a figure of merit

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/mechanical/aerospace/drone-flight-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.