

SPECTORS - project

Motor suggestions :

Motor	Controllable up to Load @25 c	T [°C]	Specific Thrust [g/w]	Hovering time [min] @25 C @ 8kg	M-MEP < L-MEP [W] @ 8kg @5 C	Price [Euro]
T-Motor U7 V2 Kv280 +18x6.1 T-Motor Carbon Propeller	11kg	46	7.61	20.4 @11kg 12.8 min	(538.2/900) =.6	1020
T-Motor MN5212 KV340 +17x5.8 T-Motor Carbon Propeller	11kg	68	6.71	18.1	(676.7/840) =.8	798.36
Brushless Motor/black (TL96020) 5008/340KV+propeller 1755	10kg	66	6.41	17.3	(603.4/680) =.89*	416.16

Controllable up to Load @25 c : with even one motor failure we can still hover and land safely.

Specific Thrust[g/w] : Thrust to power , this number is suggested to be near 7 or above.

*M-MEP < L-MEP [W] @ 8kg @5 C : Maximum Electric power of motor reaches to 0.89 of its limitation !

Some of the Advantages of T-Motor U7 V2 KV 280 :

- ✓ motor cooling 2.5 times faster than the other motors.
- ✓ water proof and sand-resistant features.
- ✓ lower noise.
- ✓ highest efficiency of 85 percent even in the case of AIR Temperature of 5 °C,
- ✓ Maximum Temperature for this motor reaches to 46 °C which is far less than the other motors.

Following comparison is done on the temperature of **5 Degree** for these three motors:

1) T-Motor U7 V2 KV 280

General Model Weight: 8000 g [incl. Drive] 282.2 oz # of Rotors: 6 Frame Size: 990 mm 37.8 inch FCU Tilt Limit: no limit Field Elevation: 28 m ASL 85 ft ASL Air Temperature: 5 °C 41 °F Pressure (QNH): 1013 hPa 29.91 inHg

Battery Cell Type (Cont. / max. C) - charge state: custom - normal Configuration: 6 S 1 P Cell Capacity: 22000 mAh max. discharge: 80% Resistance: 0.0011 Ohm Voltage: 3.7 V C-Rate: 15 C cont. 25 C max. Weight: 418.16 g 14.8 oz

Controller Type: custom Current: 35 A cont. 45 A max. Resistance: 0.0055 Ohm Weight: 50 g 1.8 oz Accessories Current drain: 3.5 A Weight: 0 g 0 oz

Motor Manufacturer - Type (KV) - Cooling: T-Motor U7-V2 0-280 (280) good search... KV (w/o torque): 280 rpm/V no-load Current: 0.4 A @ 10 V Limit (up to 15s): 900 W Resistance: 0.088 Ohm Case Length: 39.5 mm # mag. Poles: 14 Weight: 255 g 9 oz

Propeller Type - yoke twist: T-Motor CF 0° Diameter: 18 inch 457.2 mm Pitch: 6.1 inch 154.6 mm # Blades: 2 PConst / TConst: 1.15 / 1.0 Gear Ratio: 1 : 1 calculate

Remarks:

Battery	Motor @ Optimum Efficiency	Motor @ Maximum	Motor @ Hover	Total Drive	Multicopter
Load: 7.14 C	Current: 12.47 A	Current: 25.60 A	Current: 7.72 A	Drive Weight: 4773 g	All-up Weight: 8000 g
Voltage: 21.16 V	Voltage: 21.64 V	Voltage: 21.02 V	Voltage: 21.83 V	Drive Weight: 168.4 oz	add. Payload: 8796 g
Rated Voltage: 22.20 V	Revolutions*: 5828 rpm	Revolutions*: 5413 rpm	Revolutions*: 3276 rpm	Thrust-Weight: 2.1 : 1	max. Tilt: 57 °
Energy: 488.4 Wh	electric Power: 289.8 W	electric Power: 538.2 W	Throttle (log): 43 %	Current @ Hover: 46.33 A	max. Speed: 54 km/h
Total Capacity: 22000 mAh	mech. Power: 249.7 W	mech. Power: 468.1 W	Throttle (linear): 58 %	P(in) @ Hover: 1028.5 W	est. rate of climb: 5.8 m/s
Used Capacity: 17600 mAh	Efficiency: 92.6 %	Power-Weight: 403.7 W/kg	electric Power: 168.6 W	P(out) @ Hover: 911.7 W	max. Speed: 33.5 mph
min. Flight Time: 6.7 min		183.1 W/lb	mech. Power: 151.9 W	Efficiency @ Hover: 88.6 %	Total Disc Area: 68.50 dm²
Mixed Flight Time: 17.5 min		Efficiency: 90.3 %	Power-Weight: 128.6 W/kg	Current @ max: 153.61 A	with Rotor fail:
Hover Flight Time: 21.2 min		est. Temperature: 22 °C	58.3 W/lb	P(in) @ max: 3410.2 W	
Weight: 2509 g 88.5 oz		72 °F	Efficiency: 90.1 %	P(out) @ max: 2916.6 W	
		Wattmeter readings	est. Temperature: 10 °C	Efficiency @ max: 85.5 %	
		Current: 153.6 A	50 °F		
		Voltage: 21.16 V	specific Thrust: 7.91 g/W		
		Power: 3250.2 W	0.28 oz/W		

2) T-Motor MN5212 KV 340

General Model Weight: 8000 g [incl. Drive] 282.2 oz # of Rotors: 6 Frame Size: 990 mm 37.8 inch FCU Tilt Limit: no limit Field Elevation: 28 m ASL 85 ft ASL Air Temperature: 5 °C 41 °F Pressure (QNH): 1013 hPa 29.91 inHg

Battery Cell Type (Cont. / max. C) - charge state: custom - normal Configuration: 6 S 1 P Cell Capacity: 22000 mAh max. discharge: 80% Resistance: 0.0011 Ohm Voltage: 3.7 V C-Rate: 15 C cont. 25 C max. Weight: 418.16 g 14.8 oz

Controller Type: custom Current: 35 A cont. 45 A max. Resistance: 0.0055 Ohm Weight: 50 g 1.8 oz Accessories Current drain: 3.5 A Weight: 0 g 0 oz

Motor Manufacturer - Type (KV) - Cooling: T-Motor MN5212-340 (340) good search... KV (w/o torque): 340 rpm/V no-load Current: 1.1 A @ 10 V Limit (up to 15s): 840 W Resistance: 0.089 Ohm Case Length: 34 mm # mag. Poles: 22 Weight: 205 g 7.2 oz

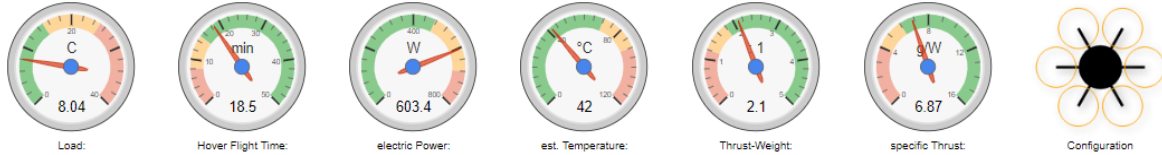
Propeller Type - yoke twist: T-Motor CF 0° Diameter: 17 inch 431.8 mm Pitch: 5.8 inch 147.3 mm # Blades: 2 PConst / TConst: 1.15 / 1.0 Gear Ratio: 1 : 1 calculate

Remarks:

Battery	Motor @ Optimum Efficiency	Motor @ Maximum	Motor @ Hover	Total Drive	Multicopter
Load: 9.07 C	Current: 23.18 A	Current: 32.69 A	Current: 8.76 A	Drive Weight: 4443 g	All-up Weight: 8000 g
Voltage: 20.88 V	Voltage: 21.15 V	Voltage: 20.70 V	Voltage: 21.78 V	Drive Weight: 156.7 oz	add. Payload: 7844 g
Rated Voltage: 22.20 V	Revolutions*: 6849 rpm	Revolutions*: 6272 rpm	Revolutions*: 3685 rpm	Thrust-Weight: 2.3 : 1	max. Tilt: 60 °
Energy: 488.4 Wh	electric Power: 490.4 W	electric Power: 676.7 W	Throttle (log): 40 %	Current @ Hover: 52.59 A	max. Speed: 61 km/h
Total Capacity: 22000 mAh	mech. Power: 420.2 W	mech. Power: 573.5 W	Throttle (linear): 55 %	P(in) @ Hover: 1167.4 W	est. rate of climb: 8.8 m/s
Used Capacity: 17600 mAh	Efficiency: 85.7 %	Power-Weight: 507.5 W/kg	electric Power: 190.9 W	P(out) @ Hover: 965.3 W	Total Disc Area: 1339 ft²/min
min. Flight Time: 5.3 min		230.2 W/lb	mech. Power: 160.9 W	Efficiency @ Hover: 82.7 %	with Rotor fail:
Mixed Flight Time: 15.5 min		Efficiency: 84.7 %	Power-Weight: 145.9 W/kg	Current @ max: 196.13 A	
Hover Flight Time: 18.8 min		est. Temperature: 44 °C	68.2 W/lb	P(in) @ max: 4354.0 W	
Weight: 2509 g 88.5 oz		111 °F	Efficiency: 84.3 %	P(out) @ max: 3440.9 W	
		Wattmeter readings	est. Temperature: 16 °C	Efficiency @ max: 79.0 %	
		Current: 196.14 A	61 °F		
		Voltage: 20.88 V	specific Thrust: 6.98 g/W		
		Power: 4095.4 W	0.25 oz/W		

3) 5008/340KV Brushless Motor/black (TL96020)

General	Model Weight: 8000 g (incl. Drive) / 282.2 oz	# of Rotors: 6 S 1 P	Frame Size: 960 mm / 37.8 inch	FCU Tilt Limit: no limit	Field Elevation: 26 mASL / 85 ftASL	Air Temperature: 5 °C / 41 °F	Pressure (QNH): 1013 hPa / 29.91 inHg	
Battery Cell	Type (Cont. / max. C) - charge state: custom / normal	Configuration: 6 S 1 P	Cell Capacity: 22000 mAh / 22000 mAh total	max. discharge: 80%	Resistance: 0.0011 Ohm	Voltage: 3.7 V	C-Rate: 15 C cont. / 25 C max	Weight: 418.16 g / 14.8 oz
Controller	Type: custom	Current: 35 A cont. / 45 A max	Resistance: 0.0055 Ohm	Weight: 50 g / 1.8 oz	Accessories			Current drain: 3.5 A / 0 g
Motor	Manufacturer - Type (Kv) - Cooling: Tarcot - 5008/340KV (340) - good	KV (w/o torque): 340 rpm/V	no-load Current: 1.1 A @ 25.2 V	Limit (up to 15s): 880 W	Resistance: 0.1 Ohm	Case Length: 35 mm / 1.38 inch	# mag. Poles: 14	Weight: 168 g / 5.9 oz
Propeller	Type - yoke twist: T-Motor CF - 0°	Diameter: 17 inch / 431.8 mm	Pitch: 5.5 inch / 139.7 mm	# Blades: 2	PConst / TConst: 1.15 / 1.0	Gear Ratio: 1 : 1	calculate	



Remarks:	Battery	Motor @ Optimum Efficiency	Motor @ Maximum	Motor @ Hover	Total Drive	Multiicopter
	Load: 8.04 C Voltage: 21.03 V Rated Voltage: 22.20 V Energy: 488.4 Wh Total Capacity: 22000 mAh Used Capacity: 17600 mAh min. Flight Time: 8.0 min Mixed Flight Time: 15.5 min Hover Flight Time: 18.5 min Weight: 2509 g / 88.5 oz	Current: 14.45 A Voltage: 21.55 V Revolutions*: 6835 rpm electric Power: 311.5 W mech. Power: 271.0 W Efficiency: 87.0 %	Current: 28.91 A Voltage: 20.87 V Revolutions*: 6114 rpm electric Power: 603.4 W mech. Power: 503.0 W Power-Weight: 452.5 W/kg Efficiency: 83.4 % est. Temperature: 42 °C / 108 °F Wattmeter readings Current: 173.46 A Voltage: 21.03 V Power: 3647.9 W	Current: 8.91 A Voltage: 21.78 V Revolutions*: 3730 rpm Throttle (log): 44 % Throttle (linear): 58 % electric Power: 194.1 W mech. Power: 160.9 W Power-Weight: 148.4 W/kg Efficiency: 82.9 % est. Temperature: 17 °C / 63 °F specific Thrust: 6.87 g/W / 0.24 oz/W	Drive Weight: 4199 g / 148.1 oz Thrust-Weight: 2.1 : 1 Current @ Hover: 53.48 A P(in) @ Hover: 1187.2 W P(out) @ Hover: 955.3 W Efficiency @ Hover: 81.3 % Current @ max: 173.44 A P(in) @ max: 3850.4 W P(out) @ max: 3018.3 W Efficiency @ max: 78.4 %	All-up Weight: 8000 g / 282.2 oz add. Payload: 6513 g / 229.7 oz max. Tilt: 57 ° max. Speed: 56 km/h / 34.8 mph est. rate of climb: 5.8 m/s / 1142 ft/min Total Disc Area: 37.86 dm² / 1361.83 in² with Rotor fail:

The motor U7 KV 280 is chosen. According to that motor some calculations have been done to evaluate the optimal number of batteries.

Battery arrangement:

Battery capacity (mAh)	Battery Weight (g)	AUW (g)	Hover Time (min)	Add up to AUW (kg)@ 80% Throttle	Controllable even with one Rotor failure	Cost [Euro]
1 * 22000	2509	6273 (only drone set-up)	31.8	4.7	yes	429
		9273 (spore-set up)	20.8	1.7	yes	
2 * 1200	3154	7600 (only drone set-up)	25.9	3.4	yes	217
		9600 (spore-set up)	18.1	1.4	yes	
3 * 7000	2721	7100 (only drone set-up)	28.8	4.1	yes	130
		9100 (spore-set up)	19.7	2.1	yes	

Because of the following facts 3 7000 mAh batteries have been chosen:

- 1) weight balance between the battery and the spore set up.
- 2) within a failure still two more batteries are available to land the drone safely.
- 3) in case of defection of one battery, the cost covering will be much less to buy another battery.

For the case of U7 KV 280 with the battery of 3*7000 mAh ,25 C an overview can be built:

Battery capacity (mAh)	Battery Weight (g)	AUW (g) (only drone set-up)	Hover Time (min)
3 * 7000	2721	7100	25.2

General Model Weight: **7100 g** incl. Drive 250.4 oz # of Rotors: 6 Frame Size: 960 mm / 37.8 inch FCU Tilt Limit: no limit Field Elevation: 26 m ASL / 85 ft ASL Air Temperature: 25 °C / 77 °F Pressure (QNH): 1013 hPa / 29.91 inHg

Battery Cell Type (Cont. / max. C) - charge state: custom normal Configuration: 6 S 3 P Cell Capacity: 7000 mAh max. discharge: 80% Resistance: 0.003 Ohm Voltage: 3.7 V C-Rate: 15 C cont. / 25 C max Weight: 115 g / 4.1 oz

Controller Type: custom Current: 40 A cont. / 40 A max Resistance: 0.0055 Ohm Weight: 50 g / 1.8 oz Accessories Current drain: 0 A Weight: 0 g

Motor Manufacturer - Type (Kv) - Cooling: T-Motor good U7-V2 0-280 (280) search... Prop-Kv-Wizard no-load Current: 0.4 A @ 10 V Limit (up to 15s): 900 W Resistance: 0.066 Ohm Case Length: 39.5 mm / 1.56 inch # mag. Poles: 14 Weight: 255 g / 9 oz

Propeller Type - yoke twist: T-Motor CF 0° Diameter: 18 inch / 457.2 mm Pitch: 6.1 inch / 154.9 mm # Blades: 2 PConst / TConst: 1.15 / 1.0 Gear Ratio: 1 : 1 calculate

Remarks:

Battery	Motor @ Optimum Efficiency	Motor @ Maximum	Motor @ Hover	Total Drive	Multicopter
Load: 6.91 C	Current: 11.99 A	Current: 24.18 A	Current: 6.68 A	Drive Weight: 4290 g	All-up Weight: 7100 g
Voltage: 21.33 V	Voltage: 21.70 V	Voltage: 21.20 V	Voltage: 21.92 V	Drive Weight: 151.3 oz	All-up Weight: 250.4 oz
Rated Voltage: 22.20 V	Revolutions*: 5836 rpm	Revolutions*: 5450 rpm	Revolutions*: 3195 rpm	Thrust-Weight: 2.3 : 1	add. Payload: 6903 g
Energy: 466.2 Wh	electric Power: 260.1 W	electric Power: 512.5 W	Throttle (log): 41 %	Current @ Hover: 40.06 A	add. Payload: 243.5 oz
Total Capacity: 21000 mAh	mech. Power: 240.0 W	mech. Power: 461.7 W	Throttle (linear): 56 %	P(in) @ Hover: 889.3 W	max Tilt: 60 °
Used Capacity: 16800 mAh	Efficiency: 92.3 %	Power-Weight: 433.1 W/kg	electric Power: 146.4 W	P(out) @ Hover: 789.2 W	max. Speed: 56 km/h
min. Flight Time: 6.9 min		196.5 W/lb	mech. Power: 131.5 W	Efficiency @ Hover: 88.7 %	est. rate of climb: 6.2 m/s
Mixed Flight Time: 20.0 min		Efficiency: 90.1 %	Power-Weight: 125.3 W/kg	Current @ max: 145.07 A	est. rate of climb: 1220 ft/min
Hover Flight Time: 25.2 min		est. Temperature: 42 °C	est. Temperature: 56.8 W/lb	P(in) @ max: 3220.0 W	Total Disc Area: 98.50 dm²
Weight: 2070 g / 73 oz		108 °F	Efficiency: 89.9 %	P(out) @ max: 2770.0 W	with Rotor fail: 1526.75 in²
		Wattmeter readings	est. Temperature: 30 °C	Efficiency @ max: 86.0 %	
		Current: 145.08 A	86 °F		
		Voltage: 21.33 V	specific Thrust: 8.08 g/W		
		Power: 3094.6 W	0.29 oz/W		

Calculation of flight Time in min:
= 25.14 min

In the following you can see a payload check in a setup of 6 rotors:

The screenshot shows a configuration interface with several sections:

- General:** Model Weight: 13400 g, # of Rotors: 6, Frame Size: 960 mm, FCU Tilt Limit: no limit.
- Battery Cell:** Type: custom, Configuration: 6 S 3 P, Cell Capacity: 7000 mAh, max. discharge: 80%, Resistance: 0.003 Ohm, Voltage: 3.7 V, C-Rate: 15 C cont, 25 C max, Weight: 115 g.
- Controller:** Type: custom, Current: 40 A cont, 40 A max, Resistance: 0.0055 Ohm, Weight: 50 g, Accessories: 0 A, Current drain: 0 g.
- Motor:** Manufacturer - Type (Kv) - Cooling: T-Motor, KV (w/o torque): 280 rpm/V, no-load Current: 0.4 A @ 10 V, Limit (up to 15s): 900 W, Resistance: 0.066 Ohm, Case Length: 39.5 mm, # mag. Poles: 14, Weight: 255 g.
- Propeller:** Type - yoke twist: T-Motor CF, Diameter: 18 inch, Pitch: 6.1 inch, # Blades: 2, PConst / TConst: 1.15 / 1.0, Gear Ratio: 1 : 1.

Below the configuration are several gauges: Load (6.91 C), Hover Flight Time (9.4 min), electric Power (512.5 W), est. Temperature (42 °C), Thrust-Weight (1.2), specific Thrust (5.83 g/W), and Configuration (6 rotors).

Remarks:

- Battery:** Load: 6.91 C, Voltage: 21.33 V, Rated Voltage: 22.20 V, Energy: 466.2 Wh, Total Capacity: 21000 mAh, Used Capacity: 16500 mAh, min. Flight Time: 6.9 min, Mixed Flight Time: 8.9 min, Hover Flight Time: 9.4 min, Weight: 2070 g, 73 oz.
- Motor @ Optimum Efficiency:** Current: 11.99 A, Voltage: 21.70 V, Revolutions*: 5836 rpm, electric Power: 260.1 W, mech. Power: 240.0 W, Efficiency: 92.3 %.
- Motor @ Maximum:** Current: 24.18 A, Voltage: 21.20 V, Revolutions*: 5450 rpm, electric Power: 512.5 W, mech. Power: 461.7 W, Power-Weight: 229.5 W/kg, 104.1 W/lb, Efficiency: 90.1 %, est. Temperature: 42 °C, 108 °F.
- Motor @ Hover:** Current: 17.85 A, Voltage: 21.46 V, Revolutions*: 4390 rpm, Throttle (log): 78 %, Throttle (linear): 80 %, electric Power: 383.0 W, mech. Power: 341.0 W, Power-Weight: 177.4 W/kg, 80.5 W/lb, Efficiency: 89.0 %, est. Temperature: 39 °C, 102 °F, specific Thrust: 5.83 g/W, 0.21 oz/W.
- Total Drive:** Drive Weight: 4290 g, 151.3 oz, Thrust-Weight: 1.2 : 1, Current @ Hover: 107.09 A, P(in) @ Hover: 2377.5 W, P(out) @ Hover: 2046.2 W, Efficiency @ Hover: 86.1 %, Current @ max: 145.07 A, P(in) @ max: 3220.7 W, P(out) @ max: 2770.0 W, Efficiency @ max: 86.0 %.
- Multicopter:** All-up Weight: 13400 g, 472.7 oz, add. Payload: 320 g, 11.3 oz, max Tilt: 12 °, max. Speed: 14 km/h, 8.7 mph, est. rate of climb: 0.8 m/s, 157 ft/min, Total Disc Area: 98.50 dm², 1526.75 in², with Rotor fail: [Red X icon]

An AUW of 13.4 Kg will have the current of 17.85A. So the hovering time [min] will be as follows :
(Payload of 6.3 Kg)

$$= 9.41 \text{ min}$$

Summary:

Battery	No loading (7.1 Kg)	Spore collector load (2kg) and 3.5 A draw	6.3 Kg payload
3 * 7000mAh	25.4min	21.2 min	9.4 min

ESC suggestion:

ESC	Max current draw of motor	Continuous current rating of an ESC
T-MOTOR F35A 3-6S BLHeli 32 Dshot1200	20.5A	35A

Two important things to consider when choosing ESC:

- Continuous current rating of an ESC should be 20% greater than max current draw of motor propeller combination:
 $20.5 * 120\% = 24.6 \text{ A} < 35\text{A}$
- S rating should be equal or greater the S rating of the chosen battery. 6S ESC for 6s Battery