Will Give the proper results in JavaProp Has the Correct Spinner 11-27-21 SMALLER 2000mm diam with proper airfoils.tx...

File Edit Format View Help

r/R	c/R	β	H/D	r	c	H	t	Airfoil
[-]	[-]	[°]	[-]	[mm]	[mm]	[mm]	[mm]	[-]
0.0000	Spinner	-	-	-	-	-	-	-
0.0500	0.1777	73.9	0.5	50.0	177.7	1088.4	21.6	interpolated
0.1000	0.3138	63.4	0.6	100.0	313.8	1254.7	38.2	interpolated
0.1500	0.4499	52.9	0.6	150.0	449.9	1246.2	54.7	interpolated
0.2000	0.4969	44.9	0.6	200.0	496.9	1252.3	60.4	interpolated
0.2500	0.4924	38.7	0.6	250.0	492.4	1258.4	59.9	interpolated
0.3000	0.4653	33.9	0.6	300.0	465.3	1266.6	56.6	interpolated
0.3500	0.4302	30.1	0.6	350.0	430.2	1274.8	52.3	Clark Y, Re=100,000
0.4000	0.3946	27.1	0.6	400.0	394.6	1286.1	48.0	interpolated
0.4500	0.3596	24.6	0.6	450.0	359.6	1294.5	43.7	interpolated
0.5000	0.3275	22.6	0.7	500.0	327.5	1307.7	39.8	interpolated
0.5500	0.2981	20.9	0.7	550.0	298.1	1319.6	36.2	interpolated
0.6000	0.2709	19.5	0.7	600.0	270.9	1335.0	32.9	interpolated
0.6500	0.2456	18.2	0.7	650.0	245.6	1342.8	29.9	Clark Y, Re=100,000
0.7000	0.2162	17.1	0.7	700.0	216.2	1353.1	26.3	interpolated
0.7500	0.1860	16.2	0.7	750.0	186.0	1369.1	22.6	interpolated
0.8000	0.1584	15.3	0.7	800.0	158.4	1375.1	19.3	interpolated
0.8500	0.1308	14.6	0.7	850.0	130.8	1391.2	15.9	interpolated
0.9000	0.1002	13.9	0.7	900.0	100.2	1399.4	12.2	interpolated
0.9500	0.0696	13.3	0.7	950.0	69.6	1411.0	8.5	interpolated
1.0000	0.0331	12.8	0.7	1000.0	33.1	1427.5	4.0	Clark Y, Re=100,000

Ln 24, Col 1 | 100% | Windows (CRLF) | UTF-8

TYPE-CERTIFICATE DATA SHEET

No. IM.E.109

for

250-C28 series engines (see Note 1)

Type Certificate Holder

Rolls-Royce Corporation
450 South Meridian Street
Indianapolis, Indiana 46225-1103
USA

For Models:

250-C28B, 250-C28C, 250-C30, 250-C30G, 250-C30G/2, 250-C30M, 250-C30P, 250-C30S, 250-C40B, 250-C47B, 250-C47M, 250-C47B/8 and 250-C47E/4.

TABLE OF CONTENTS

2. Description

The engine is a free turbine turboshaft engine of modular design and incorporates a single stage centrifugal compressor, a combustor chamber with 1 fuel nozzle, a two-stage high pressure axial turbine, a two-stage free power turbine. Model 250-C47E/4 features a dual channel FADEC. Models 250-C47B, 250-C47M, 250-C40B and 250-C47B/8 feature a single channel electronic control system with a hydromechanical manual backup system. All other models are fully hydromechanically controlled.

3. Equipment

The engine equipment list is included in the Type Design Definition. The engine mounts and the starter-generator are supplied by the airframer.

4. Dimensions

Model	Length (m)	Width (m)	Height (m)
250-C28B	1.24	0.65	0.65
250-C28C	1.10	0.56	0.65
250-C30	1.10	0.56	0.65
250-C30G	1.10	0.56	0.65
250-C30G/2	1.10	0.56	0.65
250-C30M	1.10	0.56	0.65
250-C30P	1.10	0.56	0.63
250-C30S	1.10	0.56	0.65
250-C40B	1.10	0.56	0.65
250-C47B	1.10	0.56	0.64
250-C47M	1.10	0.56	0.65
250-C47B/8	1.10	0.56	0.64
250-C47E/4	1.10	0.56	0.65

5. Dry Weight

Model	Weight (kg)
250-C28B	108.0
250-C28C	107.0
250-C30	115.1
250-C30G	115.6
250-C30G/2	118.7
250-C30M	114.2
250-C30P	112.4
250-C30S	114.6
250-C40B	127.0
250-C47B	126.3
250-C47M	126.3
250-C47B/8	126.3
250-C47E/4	131.5

Dry weight includes basic engine, fuel pump, ignition, fuel control systems and electrical harness.

6. Ratings

The engine ratings are based on Sea Level ISA static conditions with no customer bleed or external power extraction.

Model	Take-Off Power (5 minutes, kW)	Maximum Continuous Power (kW)	Continuous OEI Power (kW)	30-Min OEI Power (kW	2.5 Min OEI Power (kW)	2-Min OEI Power (kW)	30-Sec OEI Power (kW)
250-C28B	373	373	-	373	410	-	-
250-C28C	373	373	-	373	410	-	-
250-C30	485	485	-	485	522	-	-
250-C30G	485	485	-	485	522	-	-
250-C30G/2	485	415	485	485	522	-	-
250-C30M	485	447	-	-	-	-	-
250-C30P	485	447	-	485	522	-	-
250-C30S	485	485	-	485	522	-	-
250-C40B	533	457	533	533	-	574	611
250-C47B	485	447	-	-	-	-	-
250-C47M	485	447	-	-	-	-	-
250-C47B/8	485	447	-	-	-	-	-
250-C47E/4	485	447	-	-	-	-	-

7. Control System

Model 250-C47E/4 features a dual channel FADEC. Models 250-C47B, 250-C47M, 250-C40B and 250-C47B/8 feature a single channel electronic control system with a hydromechanical manual backup system. All other models do not have an electronic control system and are fully hydromechanically controlled.

250-C30, 250-C30G, 250-C30G/2, 250-C30M, 250-C30P, 250-C30S, 250-C40B, 250-C47B, 250-C47M, 250-C47B/8 and 250-C47E/4 models:

	Rotation*	Speed ratio to turbine	Max shaft torque (Nm)		Maximum overhung moment (Nm)
			Continuous	Static	
Driven by gas producer turbine:					
Tachometer	CCW	0.0825	0.8	5.6	0.5
Starter-generator	CW	0.2351	62.1	124.3	16.9
Spare	CCW	0.2351	62.1	124.3	16.9
Driven by power turbine:					
Tachometer	CCW	0.137	0.8	5.6	0.5
Tachometer (250-C30G, -C30G/2 and -C40B only)	CCW	0.2168	0.5	3.6	0.5
Power take-off	CW	0.1963	850.1	1129.8	11.3
Power take-off (250-C30G only)	CW	0.3105	538.4	714.2	11.3
Power take-off (250-C30G/2 only):					
Front drive (2.5 min OEI limit maximum)	CCW	0.3105	547.5	728.0	42.9
Rear drive	CW	0.3105	37.3	37.3	1.1
Power take-off (250-C40B only):					
Front drive (30 sec OEI limit maximum)	CCW	0.3105	626.4	728.0	42.9
Front drive (30 min OEI limit maximum)	CCW	0.3105	585.7	728.0	42.9
Rear drive	CW	0.3105	37.3	37.3	1.1
Power take-off (250-C47B, -C47B/8 and -C47E/4 only):					
Front drive	CCW	0.1963	850.1	1129.8	109.5
Rear drive	CW	0.1963	850.1	1129.8	11.3
Power take-off (250-C47M only):					
Front drive	CCW	0.1963	850.1	1129.8	11.3
Rear drive	CW	0.1963	850.1	1129.8	11.3
Spare (250-C30P and -C47E/4 only)	CW	0.3925	8.9	44.6	16.9

* CW: Clockwise, CCW: Counter Clockwise

2. Speed Limits (see Note 11)

Model	Output shaft speed				Gas producer speed	
	Max transient (up to 15 sec)	Maximum sustained	Min transient (up to 15 sec)	Minimum sustained	Max transient (up to 10 sec)	Maximum sustained
250-C28B and -C28C: 100% output shaft speed = 6016 rpm 100% gas producer speed = 50940 rpm	Varies linearly from 115% at autorotation to 105% at takeoff	Varies linearly from 113% at autorotation to 103% at takeoff	-	-	105%	104%
250-C30, -C30M, -C30P, -C30S and -C47M: 100% output shaft speed = 6016 rpm 100% gas producer speed = 51000 rpm	119%	107.10%	71.80%	91.50%	106.5%	105%
250-C30G: 100% output shaft speed = 9518 rpm 100% gas producer speed = 51000 rpm	119%	107.1%	71.8%	91.5%	106.5%	105%
250-C30G/2: 100% output shaft speed = 9545 rpm 100% gas producer speed = 51000 rpm	118.7%	106.8	71.6%	91.3%	106.5%	105%
250-C40B: 100% output shaft speed = 9598 rpm 100% gas producer speed = 51000 rpm	118%	106.3%	71.2%	90.7%	106.5%	105%
250-C47B, -C47B/8, -C47E/4: 100% output shaft speed = 6317 rpm 100% gas producer speed = 51000 rpm	113.3%	102.1%	68.4%	87.1%	106.5%	105%

3. Torque Limits (see Note 11)

All torque values are given in Nm.

Model	up to 2 sec	up to 10 sec	up to 16 sec	30-Sec OEI	2-Min OEI	2.5 Min OEI	30-Min OEI	Continuous OEI	Take-Off (5 min)	Maximum Continuous
250-C28B	-	677	-	-	-	663	628	-	628	628
250-C28C	-	830	-	-	-	663	628	-	628	628
250-C30	-	-	1189	-	-	850	800	-	800	800
250-C30G	-	-	706	-	-	540	506	-	506	506
250-C30G/2	-	-	706	-	-	548	533	504	504	416
250-C30M	930	864	-	-	-	-	-	-	800	710
250-C30P	930	864	-	-	-	850	800	-	800	710
250-C30S	-	-	1189	-	-	850	800	-	800	800
250-C40B	-	-	706	626	602	-	586	555	555	458
250-C47B	930	864	-	-	-	-	-	-	800	710
250-C47M	930	864	-	-	-	-	-	-	800	710
250-C47B/8	930	864	-	-	-	-	-	-	800	710
250-C47E/4	930	864	-	-	-	-	-	-	800	710

4. Pressure Limits

4.1 Fuel Pressure

The minimum required fuel pressure varies as a function of fuel type, fuel temperature and altitude; method for determining fuel pressure is included in the relevant Installation Design Manual (see section V of this TCDS).

The maximum fuel pressure is 172 kPa for all models, except for the 250-C47E/4, for which the maximum fuel pressure is 344 kPa.

necessary to purge the unused fuel from the system before refueling with different type fuels. No fuel control adjustment is required when switching fuels.
Fuels containing Tri-Cresyl-Phosphate additives shall not be used. The approved anti-icing additives are provided in the Operation and Maintenance Manual for each engine model.

Note 6: Model 250-C30, -C30S and -C30G engines are equipped with dual ignition. All other models have a single ignition system. A dual ignition kit is available for the Model 250-C28B and -C28C engines.

Note 7: The EASA-approved Airworthiness Limitations Section of the Instructions for Continued Airworthiness is published in the Operation and Maintenance Manual, chapter 05 "Airworthiness Limitations". Distributor Information Letters (DIL) 190 and 202 establish acceptable crack limits suitable for return to service of first stage and second stage turbine wheels, respectively, in time continued (repaired) engines.

Note 8: The Engines produced under this type certificate are approved for operation with unprotected inlets having been tested in accordance with Group I and Group II Foreign Objects Ingestion criteria of FAA Advisory Circular AC 33-1B.

Note 9: Compliance with Rolls-Royce Alert Commercial Engine Bulletin CEB-A-73-3018 (Disarm N2 Electronic Overspeed Control System) and any subsequent approved revisions are an installation requirement for the Model 250-C30M and -C30P engines.

Note 10: For 250-C40B, -C47B, -C47B/8 and -C47M models, the software for the electronic engine control has been developed and tested in accordance with the provisions of Flight Critical category (level 1) of RTCA DO 178A, and RTCA DO 178B for the 250-C47E/4 model.

Note 11: Maintenance actions are required after transient temperature, speed and torque excursions, as described in the Operation and Maintenance Manual.

SECTION: ADMINISTRATIVE

I. Acronyms and Abbreviations

n/a

II. Type Certificate Holder Record

Rolls-Royce Corporation

III. Change Record

Issue	Date	Changes	TC issue
Issue 01	12 February 2016	Initial Issue	Initial Issue, 12 February 2016
Issue 02	10 May 2017	Addition of the 250-C47E/4 model	Issue 02, 10 May 2017
Issue 03	19 June 2017	Typographical error in address of TC Holder	Issue 03, 19 June 2017
Issue 04	12 October 2017	Withdrawal of Special Condition "Transient over-temperature, over-speed and over-torque limit approval" for 250-C47B/8 and 250-C47E/4 engines. Increase in N1 speed transient.	Issue 03, 19 June 2017

-END-

TYPE-CERTIFICATE DATA SHEET

No. IM.E.109

for

250-C28 series engines (see Note 1)

Type Certificate Holder

Rolls-Royce Corporation
450 South Meridian Street
Indianapolis, Indiana 46225-1103
USA

For Models:

250-C28B, 250-C28C, 250-C30, 250-C30G, 250-C30G/2, 250-C30M, 250-C30P, 250-C30S, 250-C40B, 250-C47B, 250-C47M, 250-C47B/8 and 250-C47E/4.

JavaProp

Design | Airfoils | Geometry | Modify | Multi Analysis | Single Analysis | Flow Field | **Options**

Adjust the desired Option(s).

JavaProp

Version 1.70 - August 1, 2021.

• Translations
· Translation to English by Martin Hepperle, 2001.
· Translation to German by Martin Hepperle, 2001.
· Translation to French by Giorgio Toso, 2002.
· Translation to Italian by Giorgio Toso, 2002.
· Translation to Portuguese (European) by João Alveirinho Correia, 2008.

• Your current system settings
· Your user name is Bobbi.
· You are running Windows 10, Java version 1.8.0_321, Java memory is 498688 kB.
· System language code is en.
· Selected country is United States, selected language is English.

Country Settings:	English (United States)	(decimal character is: '.')
Density ρ:	0.9334	[kg/m³]
Kinematic Viscosity ν:	0.000014607	[m²/s]
Speed of Sound a:	340.29	[m/s]

Save... | Load... | ☐ Clear preferences on exit | Air | Water

Ready

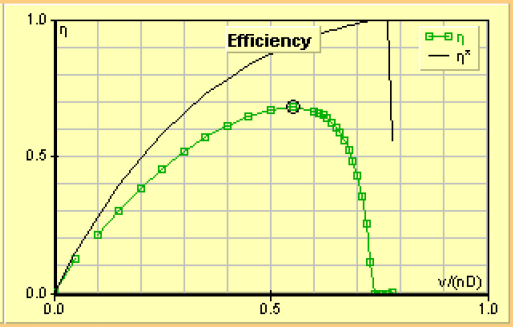
JavaProp

Design | Airfoils | Geometry | Modify | **Multi Analysis** | Single Analysis | Flow Field | Options

Propeller Off-Design Analysis for full v/nD range.

525503	2.950149	5.718842	51.59	66.05	0.00	17.43	1743	44.401	1.3141	243.26
618778	1.957924	3.438772	56.94	72.64	0.00	20.34	1743	42.396	1.1871	232.27
715804	1.331214	2.168146	61.40	78.30	0.00	23.24	1743	39.901	1.0542	218.60
818148	0.912736	1.406712	64.88	83.14	0.00	26.14	1743	36.860	0.9148	201.94
928193	0.621149	0.924038	67.22	87.29	0.00	29.05	1743	33.214	0.7686	181.97
049696	0.411351	0.604432	68.06	90.83	0.00	31.95	1743	28.917	0.6159	158.43
189081	0.256860	0.385643	66.61	93.85	0.00	34.86	1743	23.953	0.4577	131.23
220026	0.231021	0.350553	65.90	94.40	0.00	35.44	1743	22.880	0.4255	125.35
252413	0.206464	0.317677	64.99	94.93	0.00	36.02	1743	21.771	0.3928	119.28
[redacted]										

show: **Coefficients Cp, Ct** | Coefficients Pc, Tc | Thrust | Power | rpm | Torque



☐ Add to existing plots Analysis with rpm=prescribed (Results are valid for B, rpm, D, ρ from Design card)

Analyze! | Copy Text | Copy (HTML) | Print... | Save...

Ready

Basic formulas for hydraulic motors

Flow (q)

$$q = \frac{D \times n}{1000 \times \eta_v} \text{ [l/min]}$$

Torque (M)

$$M = \frac{D \times \Delta p \times \eta_{hm}}{63} \text{ [Nm]}$$

Power (P)

$$P = \frac{q \times \Delta p \times \eta_t}{600} \text{ [kW]}$$

D - displacement [cm^3/rev]
n - shaft speed [rpm]
η_v - volumetric efficiency
Δp - differential pressure [bar] (between inlet and outlet)
η_{hm} - mechanical efficiency
η_t - overall efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Basic formulas for hydraulic pumps

Flow (q)

$$q = \frac{D \times n \times \eta_v}{1000} \text{ [l/min]}$$

Torque (M)

$$M = \frac{D \times \Delta p}{63 \times \eta_{hm}} \text{ [Nm]}$$

Power (P)

$$P = \frac{q \times \Delta p}{600 \times \eta_t} \text{ [kW]}$$

D - displacement [cm^3/rev]
n - shaft speed [rpm]
η_v - volumetric efficiency
Δp - differential pressure [bar] (between inlet and outlet)
η_{hm} - mechanical efficiency
η_t - overall efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Conversion factors

1 kg	2.20 lb
1 N	0.225 lbf
1 Nm	0.738 lbf ft
1 bar	14.5 psi
1 l	0.264 US gallon
1 cm^3	0.061 cu in
1 mm	0.039 in
1°C	$^5/_9$(°F-32)
1 kW	1.34 hp

Conversion factors

1 lb	0.454 kg
1 lbf	4.448 N
1 lbf ft	1.356 Nm
1 psi	0.068948 bar
1 US gallon	3.785 l
1 cu in	16.387 cm^3
1 in	25.4 mm
1 °F	$^9/_5$°C + 32
1 hp	0.7457 kW

Pump and Motor Calculations
Altitude 9000 ft Engine @107%

Drone Wt

Drone 2100lbs + 89.4 gal fuel(600lbs) + 500lbs payload) = 3200 lbs

6 Propellers (3200 ÷ 6 = 533 lbs thrust per propeller = 2.37 kN)

Altitude 9000ft Density 0.9334 Kg/m³

Prop: 2022 rpm, 3.37 m/sec, 64 kW, 2.40 kN, 301 Nm

Motor $\frac{(301)(63)}{(59.5)(0.95)}$ = 334 Bar

Motor q= $\frac{(2022)(59.8)}{(1000)(0.95)}$ =126.6 L/min

126.6x6 = 759.6 L/min

Jet Engine @107% (6016 rpm)(1.07) = 6437 rpm

(6437)(0.53) = 3412 rpm (6437)(0.60) = 3862 rpm

Pump Gears ratio 25teeth:45teeth = 0.53 25teeth:40teeth = 0.60

Pump #1 q=$\frac{(110.1)(3412)(0.95)}{1000}$ = 356.8 L/mi

Pump #2 q=$\frac{(110.1)(3862)(0.95)}{1000}$ = 403.9 L/min

356.7+403.9 = 760.7 L/min

Pump $\frac{(110.1)(334Bar)}{(563)(0.95)}$ = 614.4 Nm

614.4 x 0.53 = 325.6 Nm

614.4 x 0.60 = 368.6 Nm

325.6+368.6 = 694.2 Nm

Engine Max Nm=800 Nm

(800 Nm max) x (0.98 engine power setting) = 784 Nm

Engine Max kw =485

694.2 Nm @ 6437 rpm = 468 kW = 627 Hp

Pump and Motor Calculations
Altitude 0 ft Engine @93.8%

ACCELERATE from 0 m/sec to 2.94 m/sec

Total Drone wt =
Drone 2100lbs + 89.4 gal fuel (600lbs) + Payload 500lbs = 3200 lbs
6 Propellers (3200 ÷ 6 = 533 lbs) = 2.37 kN thrust per propeller)

Altitude 0ft Density 1.225 Kg/m³
Prop: 1765 rpm, 0 m/sec, 62 kW, 2.477 kN, 338 Nm

Motor $\frac{(338)(63)}{(59.5)(0.95)}$ = 376.7 Bar Motor q= $\frac{(1765)(59.8)}{(1000)(0.95)}$ =111 L/min

111x6 = 666 L/min

Jet Engine @93.8% (6016 rpm)(0.938) = 5643 rpm
(5643)(0.53) = 2990 rpm (5643)(0.60) = 3385 rpm
Pump Gears ratio 25teeth:45teeth = 0.53 25teeth:40teeth = 0.60

Pump #1 q=$\frac{(110.1)(2990)(0.95)}{1000}$ = 312.7 L/mi

Pump #2 q=$\frac{(110.1)(3385)(0.95)}{1000}$ = 354 L/min

312.7+354= 666.7 L/min

Pump $\frac{(110.1)(376.7Bar)}{(563)(0.95)}$ = 693 Nm

693 x 0.53 = 367.2 Nm
693 x 0.60 = 415.8 Nm

367.2+415.8 = 783 Nm

Engine Max Nm=800 Nm Engine Max kw =485

783 Nm @ 5643 rpm = 462 kW = 620 Hp

Pump and Motor Calculations
Altitude 0 ft Engine @93.8%

ACCELERATE from 0 m/sec to 2.94 m/sec

Total Drone wt =
Drone 2100lbs + 89.4 gal fuel (600lbs) + Payload 500lbs = 3200 lbs
6 Propellers (3200 ÷ 6 = 533 lbs) = 2.37 kN thrust per propeller)

Altitude 0ft Density 1.225 Kg/m³
Prop: 1765 rpm, 0 m/sec, 62 kW, 2.477 kN, 338 Nm

2.4777 kN per prop x 6 props = 14.862 kN = total lift 3341 lbs

(Total lift 3341 lbs) - (Total Drone wt 3200 lbs) = 141 lbs excess lift

From F=ma formula Force= (mass)x(accel) accel = F÷mass

(141 lbs force)÷(3200 lbs wt) = 1.417 ft/sec² = 0.432 m/sec²

From formula V=at or Velocity= (accel)(time) Time= Velocity÷Accel

(2.94 m/sec)÷(0.432 m/sec²) = 6.8 sec

0 m/sec velocity to 2.94 m/sec @ 0.432 m/sec² accel = 6.8 sec

distance = (½)(a)(t)² = (½)(0.432)(6.8)² = 9.98 meters = 33 feet

Thus drone will start at 0 altitude and 0 m/sec
Drone will then rise up by 33 feet and have velocity of 2.94 m/sec

Engine Max Nm=800 Nm Engine Max kw =485

783 Nm @ engine rpm of 5643 = 462 kW = 620 HP

JavaProp

Design | Airfoils | Geometry | Modify | Multi Analysis | Single Analysis | Flow Field | **Options**

Adjust the desired Option(s).

JavaProp

Version 1.70 - August 1, 2021.

• Translations
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• Your current system settings
· Your user name is Bobbi.
· You are running Windows 10, Java version 1.8.0_321, Java memory is 498688 kB.
· System language code is en.
· Selected country is United States, selected language is English.

Country Settings:	English (United States)	(decimal character is: '.')
Density ρ:	1.0239	[kg/m³]
Kinematic Viscosity ν:	0.000014607	[m²/s]
Speed of Sound a:	340.29	[m/s]

Save... | Load... | ☐ Clear preferences on exit | Air | Water

Ready.

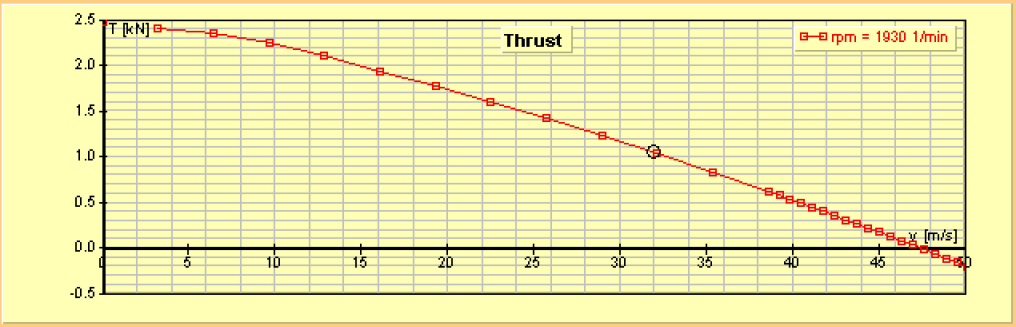
JavaProp

Design | Airfoils | Geometry | Modify | **Multi Analysis** | Single Analysis | Flow Field | Options

Propeller Off-Design Analysis for full v/nD range.

Cs	Tc	Pc	η	η*	stalled	v	rpm	Power	Thrust	Torque
[-]	[-]	[-]	[%]	[%]	[%]	[m/s]	[1/min]	[kW]	[kN]	[Nm]
000055	9.999999	9.999999	0.01	0.01	17.00 !	0.00	1930	68.127	2.4761	337.08
089072	9.999999	9.999999	12.73	15.03	57.00 !	3.22	1930	60.780	2.4051	300.73
172714	9.999999	9.999999	21.29	27.97	2.00 !	6.43	1930	70.956	2.3487	351.08
258904	9.999999	9.999999	30.33	39.38	0.00 !	9.65	1930	71.184	2.2373	352.21
345906	7.880574	9.999999	38.31	49.45	0.00 !	12.87	1930	70.467	2.0983	348.66
434938	4.637481	9.999999	45.35	58.40	0.00	16.08	1930	68.421	1.9294	338.54
525503	2.950149	5.718842	51.59	66.05	0.00	19.30	1930	66.124	1.7674	327.17

show: Coefficients Cp, Ct | Coefficients Pc, Tc | **Thrust** | Power | rpm | Torque



☐ Add to existing plots Analysis with rpm=prescribed (Results are valid for B, rpm, D, ρ from Design card)

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Ready.

Basic formulas for hydraulic motors

Flow (q)

$$q = \frac{D \times n}{1000 \times \eta_v} \text{ [l/min]}$$

Torque (M)

$$M = \frac{D \times \Delta p \times \eta_{hm}}{63} \text{ [Nm]}$$

Power (P)

$$P = \frac{q \times \Delta p \times \eta_t}{600} \text{ [kW]}$$

D - displacement [cm^3/rev]
n - shaft speed [rpm]
η_v - volumetric efficiency
Δp - differential pressure [bar] (between inlet and outlet)
η_{hm} - mechanical efficiency
η_t - overall efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Basic formulas for hydraulic pumps

Flow (q)

$$q = \frac{D \times n \times \eta_v}{1000} \text{ [l/min]}$$

Torque (M)

$$M = \frac{D \times \Delta p}{63 \times \eta_{hm}} \text{ [Nm]}$$

Power (P)

$$P = \frac{q \times \Delta p}{600 \times \eta_t} \text{ [kW]}$$

D - displacement [cm^3/rev]
n - shaft speed [rpm]
η_v - volumetric efficiency
Δp - differential pressure [bar] (between inlet and outlet)
η_{hm} - mechanical efficiency
η_t - overall efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Conversion factors

1 kg	2.20 lb
1 N	0.225 lbf
1 Nm	0.738 lbf ft
1 bar	14.5 psi
1 l	0.264 US gallon
1 cm^3	0.061 cu in
1 mm	0.039 in
1°C	$^5/_9$(°F-32)
1 kW	1.34 hp

Conversion factors

1 lb	0.454 kg
1 lbf	4.448 N
1 lbf ft	1.356 Nm
1 psi	0.068948 bar
1 US gallon	3.785 l
1 cu in	16.387 cm^3
1 in	25.4 mm
1 °F	$^9/_5$°C + 32
1 hp	0.7457 kW

Pump and Motor Calculations
Altitude 6000 ft Engine @102.2%

Drone Wt

Drone 2100lbs + 89.4 gal fuel(600lbs) + 500lbs payload) = 3200 lbs

6 Propellers (3200 ÷ 6 = 533 lbs thrust per propeller = 2.37 kN)

Altitude 6000ft Density 1.0239 Kg/m³

Prop: 1930 rpm, 3.22 m/sec, 61 kW, 2.40 kN, 301 Nm

Motor $\frac{(301)(63)}{(59.5)(0.95)}$ = 334 Bar

Motor q= $\frac{(1930)(59.8)}{(1000)(0.95)}$ =121 L/min

121x6 = 726 L/min

Jet Engine @102.2% (6016 rpm)(1.022) = 6148 rpm

(6148)(0.53) = 3258 rpm (6148)(0.60) = 3688 rpm

Pump Gears ratio 25teeth:45teeth = 0.53 25teeth:40teeth = 0.60

Pump #1 q=$\frac{(110.1)(3258)(0.95)}{1000}$ = 340.7 L/mi

Pump #2 q=$\frac{(110.1)(3688)(0.95)}{1000}$ = 385.7 L/min

340.7+385.7= 726.4 L/min

Pump $\frac{(110.1)(334Bar)}{(563)(0.95)}$ = 614.4 Nm

614.4 x 0.53 = 325.6 Nm

614.4 x 0.60 = 368.6 Nm

325.6+368.6 = 694.2 Nm

Engine Max Nm=800 Nm

(800 Nm max) x (0.98 engine power setting) = 784 Nm

Engine Max kw =485

694.2 Nm @ 6148 rpm = 447 kW = 599 Hp

JavaProp

Design | Airfoils | Geometry | Modify | Multi Analysis | Single Analysis | Flow Field | **Options**

Adjust the desired Option(s).

JavaProp

Version 1.70 - August 1, 2021.

• Translations
· Translation to English by Martin Hepperle, 2001.
· Translation to German by Martin Hepperle, 2001.
· Translation to French by Giorgio Toso, 2002.
· Translation to Italian by Giorgio Toso, 2002.
· Translation to Portuguese (European) by João Alveirinho Correia, 2008.

• Your current system settings
· Your user name is Bobbi.
· You are running Windows 10, Java version 1.8.0_321, Java memory is 498688 kB.
· System language code is en.
· Selected country is United States, selected language is English.

Country Settings:	English (United States)	(decimal character is: '.')
Density ρ:	1.1210	[kg/m³]
Kinematic Viscosity ν:	0.000014607	[m²/s]
Speed of Sound a:	340.29	[m/s]

Save... | Load... | ☐ Clear preferences on exit | Air | Water

Ready.

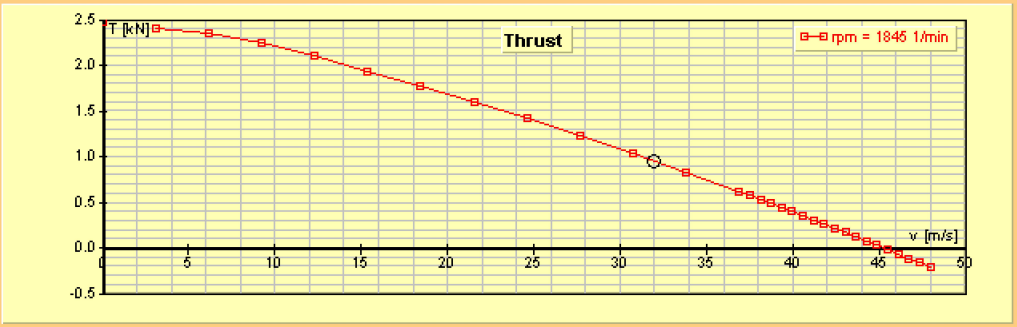
JavaProp

Design | Airfoils | Geometry | Modify | **Multi Analysis** | Single Analysis | Flow Field | Options

Propeller Off-Design Analysis for full v/nD range.

Cs	Tc	Pc	η	η*	stalled	v	rpm	Power	Thrust	Torque
[-]	[-]	[-]	[%]	[%]	[%]	[m/s]	[1/min]	[kW]	[kN]	[Nm]
000055	9.999999	9.999999	0.01	0.01	17.00 !	0.00	1845	65.161	2.4774	337.26
089072	9.999999	9.999999	12.73	15.03	57.00 !	3.08	1845	58.134	2.4063	300.89
172714	9.999999	9.999999	21.29	27.97	2.00 !	6.15	1845	67.866	2.3499	351.26
258904	9.999999	9.999999	30.33	39.38	0.00 !	9.23	1845	68.085	2.2385	352.39
345906	7.880574	9.999999	38.31	49.45	0.00 !	12.30	1845	67.399	2.0994	348.84
434938	4.637481	9.999999	45.35	58.40	0.00	15.38	1845	65.442	1.9304	338.71
525503	2.950149	5.718842	51.59	66.05	0.00	18.45	1845	63.244	1.7683	327.34

show: Coefficients Cp, Ct | Coefficients Pc, Tc | **Thrust** | Power | rpm | Torque



☐ Add to existing plots Analysis with rpm=prescribed (Results are valid for B, rpm, D, ρ from Design card)

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Basic formulas for hydraulic motors

Flow (q)

$$q = \frac{D \times n}{1000 \times \eta_v} \text{ [l/min]}$$

Torque (M)

$$M = \frac{D \times \Delta p \times \eta_{hm}}{63} \text{ [Nm]}$$

Power (P)

$$P = \frac{q \times \Delta p \times \eta_t}{600} \text{ [kW]}$$

D - displacement [cm^3/rev]
n - shaft speed [rpm]
η_v - volumetric efficiency
Δp - differential pressure [bar] (between inlet and outlet)
η_{hm} - mechanical efficiency
η_t - overall efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Basic formulas for hydraulic pumps

Flow (q)

$$q = \frac{D \times n \times \eta_v}{1000} \text{ [l/min]}$$

Torque (M)

$$M = \frac{D \times \Delta p}{63 \times \eta_{hm}} \text{ [Nm]}$$

Power (P)

$$P = \frac{q \times \Delta p}{600 \times \eta_t} \text{ [kW]}$$

D - displacement [cm^3/rev]
n - shaft speed [rpm]
η_v - volumetric efficiency
Δp - differential pressure [bar] (between inlet and outlet)
η_{hm} - mechanical efficiency
η_t - overall efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Conversion factors

1 kg	2.20 lb
1 N	0.225 lbf
1 Nm	0.738 lbf ft
1 bar	14.5 psi
1 l	0.264 US gallon
1 cm^3	0.061 cu in
1 mm	0.039 in
1°C	$^5/_9$(°F-32)
1 kW	1.34 hp

Conversion factors

1 lb	0.454 kg
1 lbf	4.448 N
1 lbf ft	1.356 Nm
1 psi	0.068948 bar
1 US gallon	3.785 l
1 cu in	16.387 cm^3
1 in	25.4 mm
1 °F	$^9/_5$°C + 32
1 hp	0.7457 kW

Pump and Motor Calculations
Altitude 3000 ft Engine @98%

Drone Wt

Drone 2100lbs + 89.4 gal fuel(600lbs) + 500lbs payload) = 3200 lbs

6 Propellers (3200 ÷ 6 = 533 lbs thrust per propeller = 2.37 kN)

Altitude 3000ft Density 1.1210 Kg/m³

Prop: 1845 rpm, 3.08 m/sec, 58 kW, 2.40 kN, 301 Nm

Motor $\frac{(301)(63)}{(59.5)(0.95)}$ = 334 Bar

Motor q= $\frac{(1845)(59.8)}{(1000)(0.95)}$ =116 L/min

116x6 = 697 L/min

Jet Engine @98% (6016 rpm)(0.98) = 5896 rpm

(5896)(0.53) = 3125 rpm (5643)(0.60) = 3538 rpm

Pump Gears ratio 25teeth:45teeth = 0.53 25teeth:40teeth = 0.60

Pump #1 q=$\frac{(110.1)(3125)(0.95)}{1000}$ = 327 L/mi

Pump #2 q=$\frac{(110.1)(3538)(0.95)}{1000}$ = 370 L/min

327+370= 697 L/min

Pump $\frac{(110.1)(334Bar)}{(563)(0.95)}$ = 614.4 Nm

614.4 x 0.53 = 325.6 Nm

614.4 x 0.60 = 368.6 Nm

325.6+368.6 = 694.2 Nm

Engine Max Nm=800 Nm

(800 Nm max) x (0.98 engine power setting) = 784 Nm

Engine Max kw =485

694.2 Nm @ 5896 rpm = 429 kW = 575 Hp

JavaProp

Design | Airfoils | Geometry | Modify | Multi Analysis | Single Analysis | Flow Field | **Options**

Adjust the desired Option(s).

JavaProp

Version 1.70 - August 1, 2021.

• Translations
· Translation to English by Martin Hepperle, 2001.
· Translation to German by Martin Hepperle, 2001.
· Translation to French by Giorgio Toso, 2002.
· Translation to Italian by Giorgio Toso, 2002.
· Translation to Portuguese (European) by João Alveirinho Correia, 2008.

• Your current system settings
· Your user name is Bobbi.
· You are running Windows 10, Java version 1.8.0_321, Java memory is 498688 kB.
· System language code is en.
· Selected country is United States, selected language is English.

Country Settings:	English (United States)	(decimal character is: '.')
Density ρ:	1.2250	[kg/m³]
Kinematic Viscosity ν:	0.000014607	[m²/s]
Speed of Sound a:	340.29	[m/s]

Save... | Load... | ☐ Clear preferences on exit | Air | Water

Ready

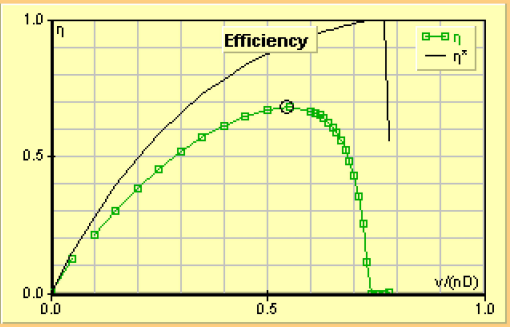
JavaProp

Design | Airfoils | Geometry | Modify | **Multi Analysis** | Single Analysis | Flow Field | Options

Propeller Off-Design Analysis for full v/nD range.

Cs	Tc	Pc	η	η*	stalled	v	rpm	Power	Thrust	Torque
[-]	[-]	[-]	[%]	[%]	[%]	[m/s]	[1/min]	[kW]	[kN]	[Nm]
000055	9.999999	9.999999	0.01	0.01	17.00 !	0.00	1765	62.339	2.4776	337.28
089072	9.999999	9.999999	12.73	15.03	57.00 !	2.94	1765	55.616	2.4065	300.91
172714	9.999999	9.999999	21.29	27.97	2.00 !	5.88	1765	64.927	2.3501	351.28
258904	9.999999	9.999999	30.33	39.38	0.00 !	8.83	1765	65.137	2.2386	352.41
345906	7.880574	9.999999	38.31	49.45	0.00 !	11.77	1765	64.480	2.0995	348.86
434938	4.637481	9.999999	45.35	58.40	0.00	14.71	1765	62.608	1.9305	338.73
525503	2.950149	5.718842	51.59	66.05	0.00	17.65	1765	60.506	1.7684	327.36

show: **Coefficients Cp, Ct** | Coefficients Pc, Tc | Thrust | Power | rpm | Torque



☐ Add to existing plots Analysis with rpm=prescribed (Results are valid for B, rpm, D, ρ from Design card)

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Basic formulas for hydraulic motors

Flow (q)

$$q = \frac{D \times n}{1000 \times \eta_v} \text{ [l/min]}$$

Torque (M)

$$M = \frac{D \times \Delta p \times \eta_{hm}}{63} \text{ [Nm]}$$

Power (P)

$$P = \frac{q \times \Delta p \times \eta_t}{600} \text{ [kW]}$$

D - displacement [cm^3/rev]
n - shaft speed [rpm]
η_v - volumetric efficiency
Δp - differential pressure [bar] (between inlet and outlet)
η_{hm} - mechanical efficiency
η_t - overall efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Basic formulas for hydraulic pumps

Flow (q)

$$q = \frac{D \times n \times \eta_v}{1000} \text{ [l/min]}$$

Torque (M)

$$M = \frac{D \times \Delta p}{63 \times \eta_{hm}} \text{ [Nm]}$$

Power (P)

$$P = \frac{q \times \Delta p}{600 \times \eta_t} \text{ [kW]}$$

D - displacement [cm^3/rev]
n - shaft speed [rpm]
η_v - volumetric efficiency
Δp - differential pressure [bar] (between inlet and outlet)
η_{hm} - mechanical efficiency
η_t - overall efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

Conversion factors

1 kg	2.20 lb
1 N	0.225 lbf
1 Nm	0.738 lbf ft
1 bar	14.5 psi
1 l	0.264 US gallon
1 cm^3	0.061 cu in
1 mm	0.039 in
1°C	$^5/_9$(°F-32)
1 kW	1.34 hp

Conversion factors

1 lb	0.454 kg
1 lbf	4.448 N
1 lbf ft	1.356 Nm
1 psi	0.068948 bar
1 US gallon	3.785 l
1 cu in	16.387 cm^3
1 in	25.4 mm
1 °F	$^9/_5$°C + 32
1 hp	0.7457 kW

Pump and Motor Calculations
Altitude 0 ft Engine @93.8%

Drone Wt

Drone 2100lbs + 89.4 gal fuel(600lbs) + 500lbs payload) = 3200 lbs

6 Propellers (3200 ÷ 6 = 533 lbs thrust per propeller = 2.37 kN)

Altitude 0ft Density 1.225 Kg/m³

Prop: 1765 rpm, 2.94 m/sec, 56 kW, 2.40 kN, 301 Nm

Motor $\frac{(301)(63)}{(59.5)(0.95)}$ = 334 Bar

Motor q= $\frac{(1765)(59.8)}{(1000)(0.95)}$ =111 L/min

111x6 = 666 L/min

Jet Engine @93.8% (6016 rpm)(0.938) = 5643 rpm

(5643)(0.53) = 2990 rpm (5643)(0.60) = 3385 rpm

Pump Gears ratio 25teeth:45teeth = 0.53 25teeth:40teeth = 0.60

Pump #1 q=$\frac{(110.1)(2990)(0.95)}{1000}$ = 312.7 L/mi

Pump #2 q=$\frac{(110.1)(3385)(0.95)}{1000}$ = 354 L/min

312.7+354= 666.7 L/min

Pump $\frac{(110.1)(334Bar)}{(563)(0.95)}$ = 614.4 Nm

614.4 x 0.53 = 325.6 Nm

614.4 x 0.60 = 368.6 Nm

325.6+368.6 = 694.2 Nm

Engine Max Nm=800 Nm

(800 Nm max) x (0.938 engine power setting) = 750.4 Nm

Engine Max kw =485

694.2 Nm @ 5643 rpm = 410 kW = 550 Hp