*cg***Calc** - Center of Gravitiy (CG) Calculator

Full Member Version

1'516'884 simulated Center of Gravitiy

The *cg***Calc** of eCalc.ch not only calculates and evaluates the center of gravity (CG), neutral point (NP) and mean aerodynamic chord (MAC) but also visualizes your design of conventional aircraft, flying wing, delta or canard. Approximate complex wing design with **5 trapezoidal wing panels**. For further instructions see below...

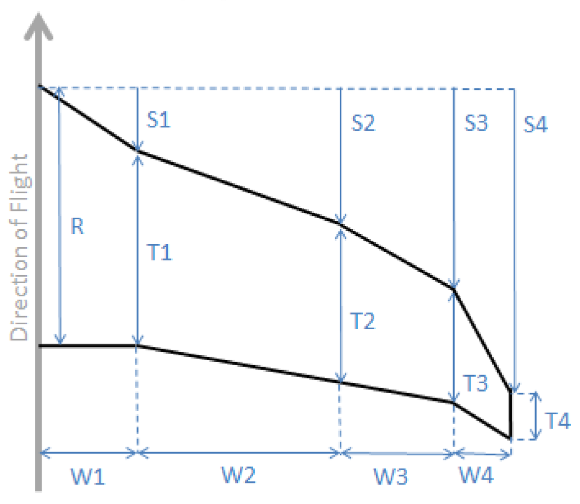
Never ever exceed Center of Gravity on maiden flight!
Select always the more conservative CG of the manufacturer and cgCalc for your maiden flight and read the limitations below.

Units: cm

Deutsch | Login

Aircraft or Project Name:	P-40					
Wing:	Monoplane					
Root Chord [R]:	72 cm					
Tip Chord [T1-T5]:	72	39	33	9	0	cm
Sweep [S1 - S5]:	0	3	3	11	13.5	cm
Panel Span [W1 - W5]:	1	130	7	13	3.5	cm
Tail:	std. Stabilizer (80%) (Tail Effectivness)					
Root Chord [R]:	45 cm					
Tip Chord [T1-T5]:	38	45	21	0	0	cm
Sweep [S1 - S5]:	0	2	16	0	10	cm
Panel Span [W1 - W5]:	4	3	43	0	0	cm

Datum is the leading edge of the center chord R



(if less than 5 half wing panels are required, define the panel Chord, Sweep and span as 0 starting from the far right with W5)

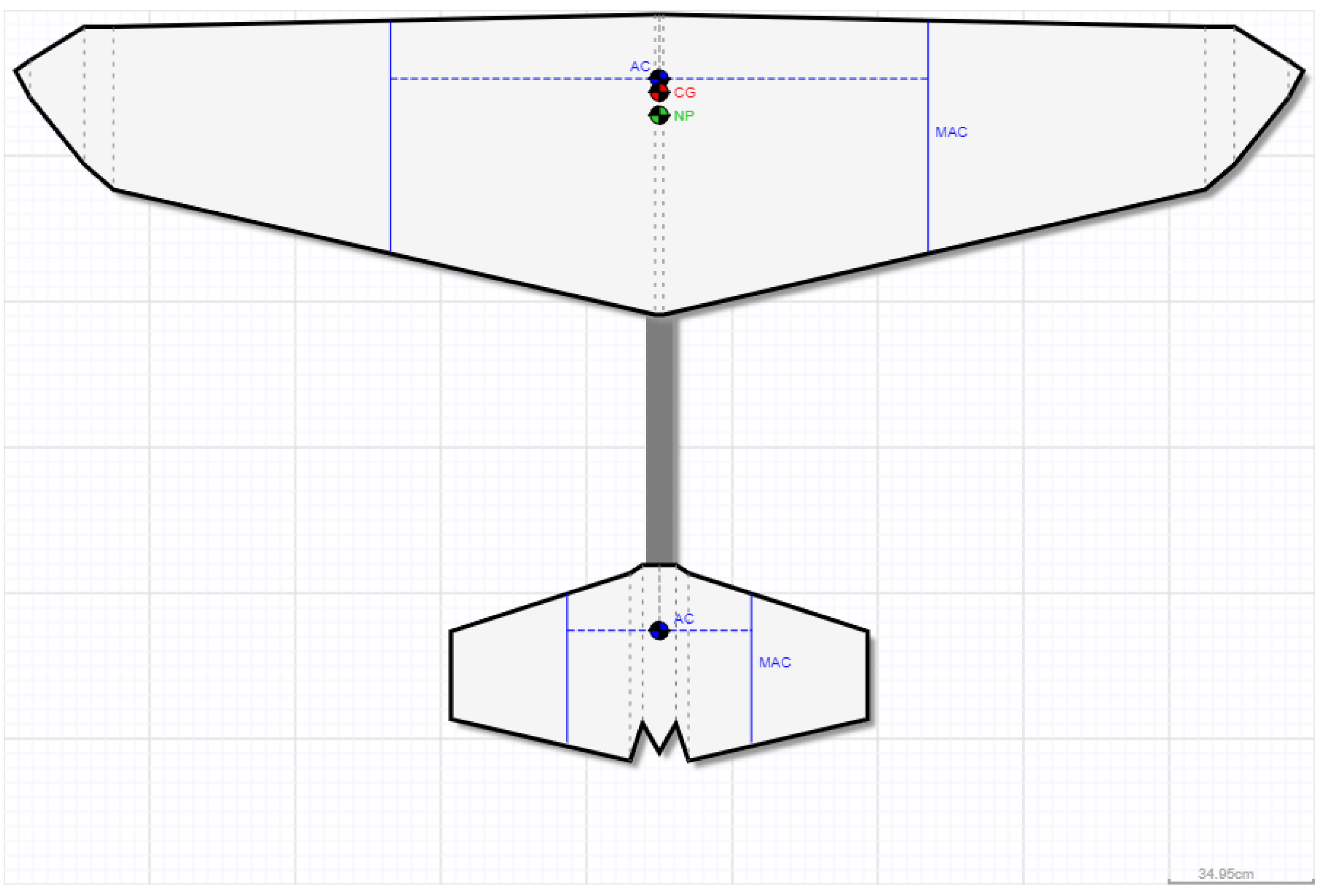
delete all Segments 2-5

Distance LE Wing to Tail [D]:	132 cm (use negative value for canard)
AC Position:	25 % of MAC (default: 25%)
Static Margin:	15.0 ... 10.0 % of MAC (recommended: **15.0...7.5%**)
Fuselage:	neglected
Width:	20 cm
Length:	165 cm
Nose Overhang:	30 cm

calculate

Results: Link to recall P-40

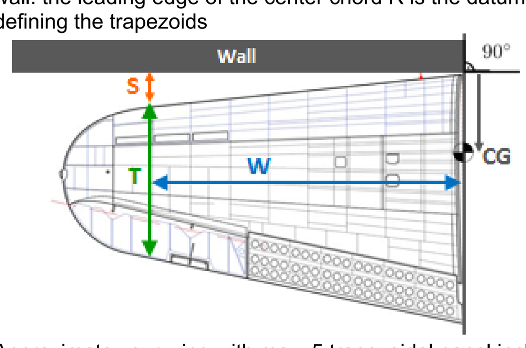
Aircraft CG range [●]:	**15.86 ... 18.63** cm (@ 25.82 ... 30.82% of MAC)	Aircraft NP [●]:	24.16 cm (@ 40.82% of MAC)
Wing AC [●]:	15.41 cm (@ 25% of MAC)	Tail AC [●]:	15.76 cm (@ 25% of MAC)
Wing MAC @ Distance	55.31 cm @ 64.53 cm	Tail MAC @ Distance	35.67 cm @ 22.09 cm
Wing Sweep @ MAC:	1.58 cm	Tail Sweep @ MAC:	6.84 cm
Wing Span:	309.00 cm	Tail Span:	100.00 cm
Wing Area:	**15655.50** cm²	Tail Area:	**3419.00** cm²
Wing Aspect Ratio:	6.10	Tail Aspect Ratio:	2.92
Fuselage influence:	0.00cm (= 0.00% of MAC)	Stabilizer Volume (V_{bar}):	0.52



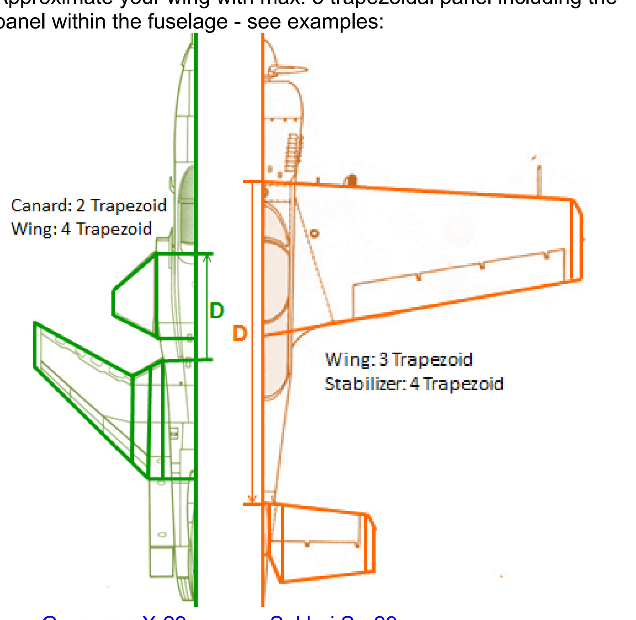
Bob Parks about *cg***Calc**:
«Markus, Yes, I am being fussy about this! And I very deliberately picked a very difficult case (canard/tandemwing) to test your calculator! For relatively normal airplanes, you already have what I think is ***BY FAR the best thing I have seen on the internet.*** *I will certainly refer people to it.»*
Bob Parks was chief designer for the Chicken Whisperers team for Red Bull FlugTag Long Beach 2013

How to use:

1. Select the units of measurements.
2. Take your wing or entire airplan and align it in a right angle to a wall. the leading edge of the center chord R is the datum for defining the trapezoids



3. Approximate your wing with max. 5 trapezoidal panel including the panel within the fuselage - see examples:



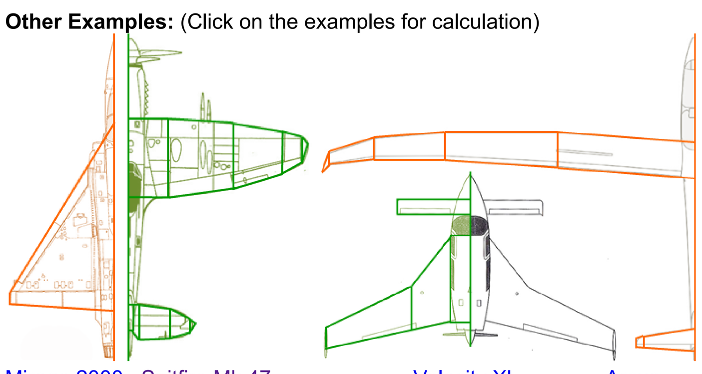
Grumman X-29 Sukhoi Su-29

4. accurately measure chord (R & T), sweep (S) and panel span (W) of each trapezoid according sketch on top.
   Remark¹: for extreme wing dihedral (V-shape) or for all V-Tail use the planform dimensions projected onto the horizontal plane.
   For a negative swept wing use negative values for S - see Arcus example below.
5. select the type of your tail (standard stabilizer, T- or V-tail, canard, flying wing or delta) and repeat 2. to 4. for your stabilizer.
   Note: Use a "small stabilizer" when the tail area is less than 10% of the wing area.
6. measure the distance (D) from the leading edge (LE) of the main wing to the leading edge of the stabilizer (see abouve).
7. define the static margin.
8. Select the Static Margin. We recommend:
   12.5...5% when considering the lift effect of the fuselage.
   17.5...10% when neglecting the fuselage.
9. Define the fuselage dimensions and the type most closely fits your fuselage shape. Insert the length WITHOUT propeller & spinner. For Delta, Wing and Canard designs the cuselage may not be calculated/inserted.
10. Plausability Check: A conventional monowing aircraft design results in a CG between 25% and 38% MAC

Results:

- Your result contains ?? you are not logged-in as a member. Login on the top or sign-up for membership.
- Verify the wing and fuselage drawing does correspond to your airplane
- Verify the wing and tail span do match the span of your plane
- Verify the wing area corresponds to manufacturers information
- The **Center of Gravity is measured in the middle of the fuselage from the leading edge (LE) of the main wing**. Positive value are towards the back, negative towards the front of the aircraft.
- Use a rather conservative CG value for inflight evaluation and approch a lower static margin (decreased stability) in small steps.

Other Examples: (Click on the examples for calculation)



Mirage 2000 Spitfire Mk 47 Velocity XL Arcus

Explanation:
It has been found both experimentally and theoretically that, if the aerodynamic force is applied at a **location of 25%** of the **Mean Aerodynamic Cord (MAC)**, the magnitude of the aerodynamic moment remains nearly constant even when the angle of attack changes. This location is called the wing's **Aerodynamic Centre (AC)**. The AC value is always measured from the **Leading Edge (LE)** in the center of the corresponding wing and includes the sweep at MAC position.

The **Neutral Point (NP)** of an aircraft is the point where the aerodynamic forces are balanced. Having two or more wings interacting on your aircraft (e.g. main wing and tail) they influence the aerodynamic forces to your aircraft. The NP value is always measured from the leading edge (LE) in the center of the main wing.
The **«tail effectivness»** influences the NP position and does not only depend on it's size, but also it's location relative to the main wing.
This must be estimated and will be between 0.9 and 0.6 for a normal tail. The closer the tail to the main wing wake or/and in disturbed air flow of a fat fuselage the lower the tail effectivness gets - even down to 0.3 in extreme.
Some typical tail effectivness are listed:
T-Tail¹: Select this option only if the tail is well **outside** the main wing plane.
V-Tail²: project the V-Tail onto the horizontal plane and use the projected dimensions.
Flying Wings & Delta: Do not have a tail (second wing). Therefore Aerodynamic Center (AC) and Neutral Point (NP) are identical.
Canard: Although the stabilizer is in front of the main wing, the stabilizer has to be defined as «tail» wing. However, make sure the Distance between main wing and tail (stabilizer) is defined as a **negative value**.
Warbird: Warbirds do have tipically a tail effectivness of around 70...75%

The **Center of Gravity (CG)** is the point where the aircraft's weight is balanced. The CG value is always measured from the leading edge (LE) in the center of the main wing respectively the leading wing for bi-planes. For longitudinal stability the CG is placed 5% to 15% of MAC in front of the NP. This margin for stability is called **Static Margin**. A lower static marging will result in less stability, a grater elevator authority (agility) and a more «tail heavy» aircraft. But any CG byond NP will lead to uncontrolable flight conditions and aircraft upset.
A higher static margin creates more stability, less elevator authoritiy (slugish pitch) and a more «nose heavy» aircraft. Too much static margin may lead to an elevator stall unable to pitch the aircraft for take-off or landing
For a **typical conventional monowing aircraft design** the CG is between 25% to 38% of MAC.
The **Stabilizer Volume** (Vbar) is a value for maneuverability. The lower the more agile the aircraft gets. Typical values are:
0.5...0.9 Trainer
0.3...0.6 Aerobatic
0.5...0.8 Glider
0.5...1.1 High-lift Jet
0.3...0.5 Combat Jet
0.0 for Delta & Flying Wing (due missing Stabilizer)

The optimal Center of Gravity must be evaluated in flight. For safety reason start CG evaluation always in a conservative manner with a static margin of 15...5% for a good longitudinal stability. Optimize CG in small steps only! **Never ever exceed the CG of cgCalc or manufacturer on maiden flight!**

Consider Fuselage
Considering the impact of fuselage is for conventional aircraft designs only. The **«Fuselage influence»** MUST be a negative value! A positive value indicates a destabilizing fuselage and the calculated CG value is INVALID. Alternatively calculate your CG by neglecting the fuselage.
For Delta, Wing and Canar configuration the influence of the fuselage's lift may not be calculated.

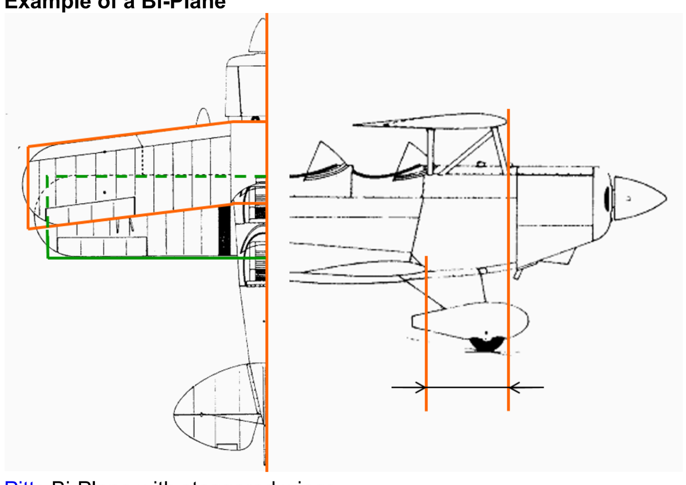
Save your project
Click the link right of «Results». The page will be reloaded with your data entries. The URL of the browser may now be saved in your browser favoties or you may copy the URL to any other document.

Limitations - what does *cg*Calc NOT do:

- *cg***Calc** does **not** provide aerodynamic performance analysis.
- Propulsion and aeroelasic effects on incidence and dynamic stability are not covered.
- Canard: For canard configuration the stabilizer is significant smaller than the main wing. For tandem wings use the «std stabilizer» option.
- **neglecting Fuselage**: *cg***Calc** does not take into account the lift effect of fuselage for conventional aircraft designs only. When neglecting the fuselage and having a fat fuselage in front the main wing, use an additional 5 to 8% static margin (see Sukhoi example uses rather 15% than 10% static margin).
  *cg***Calc** does not take into account a **long stem of the fuselage** (e.g. airliner). These lead to a considerable forward displacement of the CG. **Ignore the results** of *cg***Calc** in these cases.
- **considering Fuselage**: *cg***Calc** does take into account the lift effect of fuselage for conventional aircraft designs only. However, keep in mind this will correct the fuselage lift effect only roughly for none-fancy fuselage.
- **Jets** with intake below or ahead of the wing or **twin aircraft** with wide nacelles do have a significant destabilizing effect and is not taken into account by ***cg*Calc.**
- Usage on own risk - we reject any liablility.

*cg***Calc** is based on Simon's equation with his guidance for estimated de/da.

Example of a Bi-Plane



Pitts Bi-Plane with staggered wings

What to consider for bi-planes:
Select the option "Bi-Plane" for the "Wing" and also enter the geometry of the second wing. The "**Stagger**" defines by how much the wing is offset to the rear. It does not matter whether it is at the top or bottom. In the majority of biplanes, it is at the bottom.

Experience shows that manufacturers of **biplanes with swept wings** often disregard the sweep when specifying the C.G. (assuming a straight wing without sweep). This results in an extremely conservative CG (quite far forward).
Again, always use the more conservative CG for the first flight and then gradually move the CG back until the model behaves as desired in terms of agility and stability.

Center of gravity vs. Decalage
We hear the following question over and over again:
"I have been using eCalc for a long time and have now become aware of cgCalc. My question - the center of gravity depends on the Decalage, but I can't find it in cgCalc. But for a large glider model this is of interest - will there be an addition?"
In some (online) discussions the impression is given that C.G. position and decalage (angle of attack difference btw. wing and stabilizer) have the same relevance for flight characteristics. This article (sorry german only) is about exactly this widespread misunderstanding.

Briefly summary:
The CG determines the flight characteristics (stability) and thus influences the trim of a stable flight condition. For its part, the decalage is used exclusively for trimming, which neutrally trims your flight model to a desired and specific air speed.
The decalage has an important significance, because its misalignment can quickly lead to an unmanageable model, which is equivalent to a complete "out of trim" situation. However, it has no influence on the flight characteristics, which are based on the stability reserve of the center of gravity.

usage on own risk - we reject any liability