Four-Bar Linkage: Grashof Check and Transmission Angle

Grashof classification of a four-bar linkage from its link lengths, the linkage type, and the minimum and maximum transmission angles.

Method: Rattan; Theory of Machines; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Crank (input) length	50.000	mm
Coupler length	150.00	mm
Rocker (output) length	120.00	mm
Fixed (ground) link length	140.00	mm

Calculated results

Parameter	Value	Unit
Grashof margin (≤ 0 means Grashof)	-60.000	mm
Type (1 crank–rocker, 2 double crank, 3 double rocker, 4 non-Grashof)	1.0000	
Minimum transmission angle	36.870	°
Maximum transmission angle	88.727	°

Notes for this case

• Transmission angle extremes occur with the crank in line with the ground link; keep the minimum above about 40° for smooth force transmission. Angles valid when the crank fully rotates.

Formula and method

$$s + l \le p + q \ \text{(Grashof)}, \quad \cos\mu = \frac{b^2 + c^2 - (d \mp a)^2}{2bc}$$

Variables

a	Crank (input) length	m
b	Coupler length	m
c	Rocker (output) length	m
d	Fixed (ground) link length	m
$s+l-p-q$	Grashof margin (≤ 0 means Grashof)	m
type	Type (1 crank–rocker, 2 double crank, 3 double rocker, 4 non-Grashof)	-
μ_{min}	Minimum transmission angle	rad
μ_{max}	Maximum transmission angle	rad

Method and standards

Grashof's law and transmission angle extremes.

Assumptions and limits

- Planar pin-jointed four-bar.
- Type codes: 1 crank–rocker, 2 double crank, 3 double rocker, 4 non-Grashof. A change-point linkage (s + l = p + q) is flagged.
- The transmission angle extremes are shown only when link a turns fully (Grashof, with a or the ground link shortest).

References

• Rattan
• Theory of Machines

- 4th ed. (McGraw-Hill, 2014); Bhandari
- Design of Machine Elements
- 4th ed. (McGraw-Hill, 2017) (Grashof's law; transmission angle)

Report details

Report reference	FCC-AVXJ-9RC0 (the same inputs always give the same reference)
Generated	17 November 2026, 19:45 UTC
Calculator	Four-Bar Linkage: Grashof Check and Transmission Angle
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 reference cases of this calculator, computed independently, are checked on every release

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

This calculator online

https://calc.firecad.com/mechanical/machine-design/four-bar-grashof

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.