Cardan (Hooke) Joint Speed Fluctuation

Output speed of a single Cardan universal joint at a shaft angle and rotation position, its maximum and minimum, the fluctuation and the output angular acceleration.

Method: Kinematics of the Hooke joint

Input parameters

Unit system: SI

Parameter	Value	Unit
Joint (bend) angle	15.000	°
Input speed	3,000.0	rpm
Input shaft rotation angle	30.000	°

Calculated results

Parameter	Value	Unit
Output speed at θ	2,947.1	rpm
Maximum output speed	3,105.8	rpm
Minimum output speed	2,897.8	rpm
Speed fluctuation	6.9350	%
Output angular acceleration at θ	5,720.5	

Notes for this case

• A single Hooke joint does not transmit constant speed: $\omega_2/\omega_1 = \cos\beta/(1 - \sin^2\beta \sin^2\theta)$, varying between cos β and 1/cos β twice per revolution. The resulting second-order torsional excitation loads the driveline and is felt as vibration; it is cancelled by using two joints at equal angles with the yokes in phase (W or Z arrangement), or by constant-velocity joints. Angular acceleration is in rad/s².

Formula and method

$$\frac{\omega_2}{\omega_1} = \frac{\cos\beta}{1 - \sin^2\beta \sin^2\theta}, \quad \omega_{2,max} = \frac{\omega_1}{\cos\beta}, \quad \omega_{2,min} = \omega_1 \cos\beta$$

Variables

β	Joint (bend) angle	rad
ω_1	Input speed	rad/s
θ	Input shaft rotation angle	rad
ω_2	Output speed at θ	rad/s
$\omega_{2,max}$	Maximum output speed	rad/s
$\omega_{2,min}$	Minimum output speed	rad/s
$(\omega_{max} - \omega_{min})/\omega_1$	Speed fluctuation	-
$\dot{\omega}_2$	Output angular acceleration at θ	-

Method and standards

Cardan joint.

Assumptions and limits

- Rigid single joint; constant input speed.

References

Kinematics of the Hooke joint

Report details

Report reference	FCC-ERPM-JC4V (the same inputs always give the same reference)
Generated	23 November 2026, 18:18 UTC
Calculator	Cardan (Hooke) Joint Speed Fluctuation
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 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/automotive/transmission/cardan-joint-speed-fluctuation

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.