Satellite Eclipse Duration in a Circular Orbit

Eclipse (shadow) fraction and duration per orbit of a satellite in a circular Earth orbit from its altitude and the beta angle between the orbit plane and the Sun.

Method: Cylindrical-shadow eclipse geometry

Input parameters

Unit system: SI

Parameter	Value	Unit
Orbit altitude	550.00	km
Beta angle (Sun to orbit plane)	20.000	°

Calculated results

Parameter	Value	Unit
Orbital period	95.650	min
Beta angle above which there is no eclipse	67.016	°
Fraction of the orbit in eclipse	36.359	%
Eclipse duration per orbit	34.778	min
Sunlit time per orbit	60.872	min

Notes for this case

• Cylindrical Earth shadow, spherical Earth, circular orbit: f_E = (1/π) arccos[√(h² + 2R_E h)/((R_E + h) cos β)] for β < β*. Penumbra and atmospheric refraction add a little.

Formula and method

$$f_E = \frac{1}{\pi}\cos^{-1}\left[\frac{\sqrt{h^2+2R_E h}}{(R_E+h)\cos\beta}\right] \quad (\beta<\beta^*), \quad \beta^* = \sin^{-1}\frac{R_E}{R_E+h}$$

Variables

h	Orbit altitude	m
β	Beta angle (Sun to orbit plane)	rad
T	Orbital period	s
β^*	Beta angle above which there is no eclipse	rad
f_E	Fraction of the orbit in eclipse	-
t_E	Eclipse duration per orbit	s
t_{sun}	Sunlit time per orbit	s

Method and standards

Eclipse geometry for circular orbits.

Assumptions and limits

- Circular orbit, cylindrical shadow, spherical Earth.

References

Cylindrical-shadow eclipse geometry

Report details

Report reference	FCC-MWJB-MEYR (the same inputs always give the same reference)
Generated	23 November 2026, 17:50 UTC
Calculator	Satellite Eclipse Duration in a Circular Orbit
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/mechanical/aerospace/satellite-eclipse-duration

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.