Tracking Collector Angle of Incidence: Single and Two-Axis Modes

Angle of incidence, surface slope and azimuth and beam ratio for one- and two-axis tracking surfaces: east-west, north-south, polar, vertical-axis and full tracking.

Input parameters

Unit system: SI

Parameter	Value	Unit
Tracking mode	Horizontal east-west axis, continuous	
Latitude (north positive, south negative)	40.000	°
Day of the year (1 = 1 January, 365 = 31 December)	141.00	
Solar time (24-hour clock)	14.000	h
Slope (vertical-axis mode only)	40.000	°
Declination formula	Cooper (1969), as in the textbook examples	

Calculated results

Parameter	Value	Unit
Zenith angle	32.418	°
Solar azimuth	61.122	°
Angle of incidence	27.997	°
Cosine of the angle of incidence	0.88297	
Surface slope	17.051	°
Surface azimuth	0	°
Beam ratio, tracking to horizontal	1.0460	

Notes for this case

- Ideal tracking; real trackers stop at their travel limits and may back-track to avoid row shading.

Formula and method

$$\text{E–W daily}: \quad \cos\theta = \sin^2\delta + \cos^2\delta\cos\omega, \quad \text{E–W continuous}: \quad \cos\theta = \sqrt{1-\cos^2\delta\sin^2\omega}$$

$$\text{N–S continuous}: \quad \cos\theta = \sqrt{\cos^2\theta_z + \cos^2\delta\sin^2\omega}, \quad \text{polar}: \quad \cos\theta = \cos\delta, \quad \text{vertical axis}: \quad \cos\theta = \cos\theta_z\cos\beta + \sin\theta_z\sin\beta$$

Variables

mode	Tracking mode	-
ϕ	Latitude (north positive, south negative)	rad
n	Day of the year (1 = 1 January, 365 = 31 December)	-
t_s	Solar time (24-hour clock)	s
β	Slope (vertical-axis mode only)	rad
$\delta\ \mathrm{formula}$	Declination formula	-
θ_z	Zenith angle	rad
γ_s	Solar azimuth	rad
θ	Angle of incidence	rad
$\cos\theta$	Cosine of the angle of incidence	-

γ	Surface azimuth	rad
R_b	Beam ratio, tracking to horizontal	-

Method and standards

Incidence for surfaces moved in prescribed ways.

Assumptions and limits

- Ideal tracking with no travel limits or back-tracking.

Report details

Report reference	FCC-AY45-TZAN (the same inputs always give the same reference)
Generated	23 November 2026, 17:34 UTC
Calculator	Tracking Collector Angle of Incidence: Single and Two-Axis Modes
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	6 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/environmental/solar-thermal/solar-tracking-surface-incidence

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.