Transverse Mercator (UTM) Point Scale Factor

Point scale factor of a transverse Mercator projection such as UTM from the easting, false easting, central scale factor and earth radius, in ppm and as a factor.

Method: Transverse Mercator scale factor (spherical series)

Input parameters

Unit system: SI

Parameter	Value	Unit
Easting of the point	640,000	m
False easting	500,000	m
Scale factor on the central meridian	0.99960	
Earth radius (Gaussian mean)	6,381.0	km

Calculated results

Parameter	Value	Unit
Distance from the central meridian	140.06	km
Point scale factor	0.99984	
Scale distortion (ppm)	-159.21	
Distance where k = 1 (secant lines)	180.52	km

Notes for this case

• On a transverse Mercator projection the scale grows away from the central meridian: k ≈ k_0(1 + x^2/2R^2 + x^4/24R^4), x the true distance east or west of it (grid offset ÷ k_0). UTM uses k_0 = 0.9996 so the scale is 1 about 180 km either side; state plane TM zones use smaller zones and k_0 nearer 1. The spherical approximation is within about 1 ppm inside a zone; rigorous ellipsoidal formulas are used for control work.

Formula and method

$$k = k_0 \left(1 + \frac{x^2}{2R^2} + \frac{x^4}{24R^4}\right), \quad x = \frac{E - E_0}{k_0}$$

Variables

E	Easting of the point	m
E_0	False easting	m
k_0	Scale factor on the central meridian	-
R	Earth radius (Gaussian mean)	m
x	Distance from the central meridian	m
k	Point scale factor	-
$(k-1)10^6$	Scale distortion (ppm)	-
$x_{k=1}$	Distance where k = 1 (secant lines)	m

Method and standards

Projection scale.

Assumptions and limits

- Spherical approximation; within one zone.

References

Transverse Mercator scale factor (spherical series)

Report details

Report reference	FCC-TWZX-RGNM (the same inputs always give the same reference)
Generated	23 November 2026, 18:08 UTC
Calculator	Transverse Mercator (UTM) Point Scale Factor
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/civil/surveying/transverse-mercator-scale-factor

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.