



DrukRef23

National Reference Frame of Bhutan

Bhutan National Grid 2023 BNG2023

Summary Report

Prepared by:



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Executive Summary

Bhutan is adopting the DrukRef23 geodetic datum (aligned with ITRF2020) together with a new single-zone national projection, the Bhutan National Grid 2023 (BNG2023). The choice of projection family was established in a previous technical study, which demonstrated that a Lambert Conformal Conic with two standard parallels (LCC-2SP) offers the most suitable single-zone solution for Bhutan.

The present document provides the final operational definition of the BNG2023 projection. The two standard parallels are positioned so that they enclose the vast majority of inhabited areas of Bhutan, and the false easting and northing are selected to ensure that all grid coordinates are strictly positive and fall within a clear and compact numerical range.

The BNG2023 projection parameters are shown in Table 1

Table 1 — BNG2023 Projection Parameters

Parameter	Value
Latitude of 1 st standard parallel (lat_1)	27.65°
Latitude of 2 nd standard parallel (lat_2)	26.90°
Latitude of origin (lat_0)	27.50°
Central meridian (lon_0)	90° E
False Easting (FE)	500 000 m
False Northing (FN)	200 000 m
Ellipsoid	GRS80
Axis	Easting, Northing (m)

1 Background and objectives

The decision to adopt a Lambert Conformal Conic projection for the Bhutan National Grid 2023 (BNG2023) follows an earlier technical study, which showed that an LCC with two standard parallels gives much smaller and more uniform scale distortion across Bhutan than any single-zone Transverse Mercator (TM) previously used. Because Bhutan is wider east–west than it is tall north–south, LCC controls distortion better over the inhabited band.

In defining the final parameters of BNG2023, the main objective was to keep these low distortions while reflecting operational needs identified by NLCS technical staff. The two standard parallels, $lat_1 = 27.65^\circ$ and $lat_2 = 26.90^\circ$, were chosen so that they enclose almost all inhabited areas and key infrastructure corridors. The higher first parallel at

27.65° was adopted to give better coverage of the northern inhabited zones, while keeping the second parallel at 26.90° preserves a balanced pattern of small contractions and expansions within the band between them. Table 2 summarises the main distortion statistics for the new BNG2023 LCC and for the former DRUKREF03 TM (EPSG:5266). The “Mean” value is the average scale distortion over the evaluation domain, expressed in parts per million (ppm). “P95” is the 95th percentile, indicating that 95% of the domain has $|k-1|$ not exceeding this value. “Max $|k-1|$ ” is the worst-case absolute scale distortion found anywhere in the domain, and therefore gives the upper bound on grid scale error for that projection.

Table 2 – Comparison of BNG2023 LCC and former DRUKREF03 TM (EPSG:5266)

Projection	Mean [ppm]	P95 [ppm]	Max $ k-1 $ [ppm]
BNG2023 LCC (lat ₁ = 27.65°, lat ₂ = 26.90°)	-10.7	+13.9	21.3
DRUKREF03 TM (k ₀ = 1.00000, EPSG:5266)	+139	+459	504

The latitude of origin (27.50°) and the central meridian (90°E) follow common practice for national LCC systems and position the grid naturally with respect to Bhutan’s location. The false easting (500 000 m) and false northing (200 000 m) were selected so that all Easting and Northing values in Bhutan remain positive and fall within a clear and compact range of a few hundred kilometres, simplifying interpretation and avoiding overlap between axes. Over the approximate national extent (26.7°–28.4° N, 88.7°–92.1° E), the resulting BNG2023 coordinates span the ranges shown in Table 3.

Table 3 – Approximate range of BNG2023 coordinates over Bhutan

Component	Min (m)	Max (m)
Easting (E)	370 000	710 000
Northing (N)	110 000	300 000

2 Registry strings

2.1 PROJ string

```
+proj=lcc +lat_1=27.65 +lat_2=26.90 +lat_0=27.50 +lon_0=90 +x_0=500000 +y_0=200000 +ellps=GRS80 +units=m +no_defs
```

2.2 WKT2 definition

```
PROJCRS["Bhutan National Grid 2023 (LCC)",  
  BASEGEOGCRS["DrukRef23",  
    DATUM["DrukRef23",  
      ELLIPSOID["GRS 1980",6378137,298.257222101]],  
    PRIMEM["Greenwich",0]],  
  CONVERSION["Lambert Conic Conformal (2SP)",  
    METHOD["Lambert Conic Conformal (2SP)",  
      PARAMETER["Latitude of 1st standard parallel",27.65],  
      PARAMETER["Latitude of 2nd standard parallel",26.90],  
      PARAMETER["Latitude of false origin",27.50],  
      PARAMETER["Longitude of false origin",90],  
      PARAMETER["False easting",500000],  
      PARAMETER["False northing",200000]],  
    CS[Cartesian,2],  
    AXIS["Easting (E)",east],  
    AXIS["Northing (N)",north],  
    LENGTHUNIT["metre",1]]
```

2.3 ESRI .prj Format (WKT1)

```
PROJCS["Bhutan National Grid 2023 (LCC)",  
  GEOGCS["DrukRef23",  
    DATUM["DrukRef23",  
      SPHEROID["GRS_1980",6378137,298.257222101]],  
    PRIMEM["Greenwich",0],  
    UNIT["Degree",0.0174532925199433]],  
  PROJECTION["Lambert_Conformal_Conic_2SP"],  
  PARAMETER["standard_parallel_1",27.65],  
  PARAMETER["standard_parallel_2",26.90],  
  PARAMETER["latitude_of_origin",27.50],  
  PARAMETER["central_meridian",90],  
  PARAMETER["false_easting",500000],  
  PARAMETER["false_northing",200000],  
  UNIT["Meter",1]]
```

2.4 EPSG-style Parameter Listing

Projected CRS: Bhutan National Grid 2023 (LCC)

Base CRS:

Name: DrukRef23

Datum: DrukRef23

Ellipsoid: GRS 1980

- Semi-major axis: 6378137.0 m

- Inverse flattening: 298.257222101

Projection Method:

Lambert Conic Conformal (2SP) (EPSG method 9802)

Projection Parameters:

Latitude of 1st standard parallel: 27.65°

Latitude of 2nd standard parallel: 26.90°

Latitude of false origin: 27.50°

Longitude of false origin: 90° E

False easting: 500000 m

False northing: 200000 m

Coordinate System:

Type: Cartesian 2D

Axis 1: Easting (E), metres, east

Axis 2: Northing (N), metres, north

Units:

metre