

Aligning a System to Two Points at Ground

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Thesis

We have two points in the centerline of a roadway that runs generally East-West. We would like to build a local system based on the West point and use a 'generally accepted' truncated State Plane coordinate for this Western point. The Eastern point is an unknown distance from the Western point, we would like to build a Ground System with the Eastern Point at the Cardinal N90E direction. In this case, the Eastern point will be used for Bearing only. The computed Grid to Ground scale factor will be used for the new system.

By:

Western Point: Lat Lon Ellip

Lat Lon Ellipsoid:	37 7 48.88043 N 113 30 35.44965 W NAD8
	2786.82 Ft Ellipsoid
UT South SPC (sFeet):	1,054,514.467 SFEET E 10,017,594.041 SFEET N UTS NAD83
Truncated Local Coord:	54,514.467 SFEET E 17,594.041 SFEET N

Eastern Point:

Lat Lon Ellipsoid:

37 7 48.57847 N **113 30 0.41208** W NAD83 **2804.71** Ft Ellipsoid

Solution

Make a new job, the initial coordinate system does not matter, so we will use the underlying nominal SPC zone 'Utah South NAD83' with GEOID18 loaded:



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From the Main Menu, JOB (tab) click on Points/Measurements/Codes, then click on +Add, then enter Point 100 using Lat/Lon/EllipH:

Edit point [100]			
COORDIN	PROPERTI SKET		
Point	100		
Ν	10017594.039ft		
E	1054514.463ft		
z	2866.75ft		
Geodetic coords	Latitude-Longitude		
Latitude	N 37°07'48.88043"		
Longitude	W 113°30'35.44965"		
Height	2786.82ft		
< \	Prev Next Accept		

Click Accept, then add the Eastern Point using Lat/Lon/EllipH as Point 101:



\bigtriangledown	∽	∧	✓
	Prev	Next	Accept



We now have two points defined in our point list:

Noints/N	leasurements/Cod
POINTS	MEASURE REFE
eh 101 ال	N 10017502.680ft E 1057350.602ft Z 2884.57ft
- 100	N 10017594.039ft E 1054514.463ft Z 2866.75ft

Topographic points:	2	▼ ≣
\bigtriangledown	Tools	+ Add

We can use the CAD, Info, Distance tool to compute the Grid distance between 100 -> 101:

Distance		
Result		
Distance	2D	2837.610ft
	3D	2837.666ft
	ΔN	-91.358ft
	ΔE	2836.139ft
Heighteren	ce	17.83ft
Bearing		S
		88°09'18.0509" E
Zenith		89°38'24.0994"
Slope		0.63%
elebe		
Ellincoi, ista	200	2027 565#
		2037.3031
Ellipsoizimi	uth	s 89°23'10.9606"
\triangleleft		

The Grid distance is 2837.610 USFeet. We don't need this distance, but it will be useful for comparison in the next step.

Now, let's build a Single Point Ground system and compute the Ground distance between these two points. Go back to the Main Menu, JOB tab, then click on GNSS Localization then





Click on the black **Details** button to the right of Local – Single Point. X-PAD will ask for the Local system – Single point geographic position. Use the > button to the right of GNSS Point to recall Point 100:



Click on the Next (right arrow) at the bottom. X-PAD will show the computed State Plane



Coordinates for Point 100.:

Local system-Single point			
Local coordinate			
Local point	100		
Ν	10017594.039ft		
E	1054514.463ft		
Z	2866.75ft		
i Denne ground of the i - Selec - Enter assign	//grid coordinates in one following methods: t an existing point the coordinates and a name to the point		
\bigtriangledown	$\[Delta]$		

We want to truncate the SPC position such that only 5 significant places to the left of the decimal-point remain. Click on the >, choose New point and enter point 102 with the new local coordinates:



Click on Accept.



The truncated Local Coordinate will be shown:



Click the **Next** (right-arrow button) at the bottom.

Select an appropriate GEOID:



Then click Accept.



X-PAD will show that the GNSS Localization is Local Single Point with the selected GEOID:

X	Coordinate System	
	Cartographic system UT83 - South (LAMBERT_2SP NAD83 GRS80)	>
₩	GNSS Localization Local - Single point Geoid GEOID2018US	>
	Base pos. adjustment LL: S 0°00'00.00000" W 0°00'00.00000" H: 0.00ft	>
	Ground to grid scale fac NO Sea level reduction NO Reduction to cartographic plane	>

Return to CAD, Info, Distance and compute the distance from 100 to 101:

esult		
Distance	2D	2837.941ft
	3D	2837.997ft
	ΔN	-30.399ft
	ΔE	2837.778ft
Heighterence		17.83ft
Bearing		S 89°23'10 5176"
		89 23 10.3170 E
Zenith		89°38'24.2502"
Slope		0.63%
Point1		100
Code		

The Ground distance is **2837.94** USFeet, the Grid distance was **2837.610** USFeet. This is correct for this elevation and grid location.

We now would like to build a 2-point localization where the Eastern point has the same Northing, but the Easting is 2837.94 larger than the Western point.

54514.463 + 2837.94 = **57352.403**

Go to the Main Menu, JOB (tab), Points, Measurements, Codes and add a fourth point



103:



Click Accept.

We now have two Geographic Coordinates and two projected points to build a complete system with. Return to the Main Menu, Coordinate System, GNSS Localization and select Local – Site calibration, then click the black Details button. The Local system-Multi points dialog is shown:



Add two points:

GNSS Position 1	100
Local Coordinate 1:	100
GNSS Position 2:	101



The Local system-Multi points dialog will reflect these selections and show a Scale factor: 1.0001:

Local system-Multi points
H 0.000ft 100 - 100
Lat. N 37'07'48.88043 Lng. W 113°30'35.44965" H 2786.82ft
H 0.000ft 101 - 103 Lat. N 37°07'48.57847"
Lng. W 113°30'00.41208" H 2804.71ft
Method Barycentric Scale Conformal (scaled) Calculation completed.
Scale factor:1.0001

Uncheck the second point-pair's Vertical checkbox to prevent building a tilted-plane system.

Click the Next button (right-arrow), the Coordinate System, System Type will be shown, click the Next button at the bottom again and choose an appropriate Geoid, finally click Accept.

Note: If you don't continue through by clicking the right-arrow, then click on Accept your changes will not be kept!

If you think that you might want to reuse this system, click on **Tools**, then **Save current system** and give the new system a reasonable name.

Finally, return to the CAD screen and compute the distance from Point 100 to Point 101:

M Distance		
Result		
Distance	2D	2837.940ft
	3D	2837.996ft
	ΔN	0.000ft
	ΔE	2837.940ft
Heighterend	ce	17.83ft
Bearing	9	S 90°00'00.0000" E
Zenith	1	89°38'24.2499"
Slope	0.63%	
Point1	1	00
Code		
\bigtriangledown		

The distance is Ground (**2837.940 USFeet**) and the bearing is cardinal East as we desired.

Now that we have the desired Ground System defined from point 100, we can still use



background maps:



Coordinate System Report

You can write a Coordinate System report from Main Menu, JOB (tab), Coordinate System, Tools, Report:

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Coordinate							
Job		Demo2.gfd4	Date:	04-10-21	Time:	13:15	
System type:	Carto	graphic					
Name Projection	UT83 LAMB	- South ERT_2SP					
DATUM Name Shift.X Shift.Y Shift.Z Rot.Y Rot.Y Rot.Z Scale	0 0.0 0.0 0.0 0.0 1-	NAD83 0.000000ft 0.000000ft 0.000000ft 00000000 00000000 00000000 00000000					
ELLIPSOID Name A Inv.Flat.	GRS8 20925 298.25	0 604.474ft 57222101					
System type: Transformation:	Multip Confo	ole points ormal (with scale var	iation)				
Name	Use H V	Latitude ECEF X	WGS84 / ET Longitu ECEF	RS89 de Y	Height ECEF Z	N	UT83 - South E Calculated Reference Difference
100	Yes	N 37°07'48.88043"		W	2786.82	2ft 17594.039ft	54514.463ft
	Yes	-6664081.705ft	-1531913	3.251ft	12563753.72	2ft 17594.039ft 0.000ft	54514.463ft 0.000ft
101	Yes	N 37°07'48.57847"		Ŵ	2804.71	lft 17594.039ft	57352.403ft
	No	-6661492.433ft	-15320300	0.025ft	12563740.17	7ft 17594.039ft 0.000ft	57352.403ft 0.000ft

Shift.X Shift.Y Rot.X

-677584.749284ft -10028139.986454ft 1°50'42.391908584"

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Ζ

2866.75ft

2866.75ft 0.00ft

2884.64ft

2866.75ft ! 17.89ft



 Scale
 1+116.965ppm

 Barycenter

 N0
 10045734.025ft

 E0
 733518.182ft

 Elevations:
 Geoid

 Geoid:
 GEOID2018US

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Hint: Non-Cardinal Bearings

In the previous example, we computed the Easting coordinate of the second local point by adding the desired Ground distance to the Easting coordinate of the first point.

What if we wanted to have that bearing actually be some other, non-cardinal, bearing?



You can use the CAD, Draw, Layout drawing tool to add a new point at some distance – bearing from the first point (100):

	۵۵	103
Draw	Line	
	100	>
Point		
Point Bearing	S 89°22'4	>
Point Bearing Increment	S 89°22'4	> 0" >
Point Bearing Increment Length	\$ 89°22'4 90°00'00.000 2837.940	> 0" >
Point Bearing Increment Length Δ Elevation	\$ 89°22'4 90°00'00.000 2837.940 0.000	> 0" > ft > ft >

After clicking Add point, a new point the desired Ground distance at the entered bearing (S 89 22 44 E above) can then be used as the 2nd point's Local Coordinate.

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