

Co-ordinate Systems

It is so simple with System 500 to convert between surveyed WGS84 co-ordinates to Local Grid co-ordinates. You never actually need to worry about *how* it is actually done. But many people are still interested in co-ordinate types and conversions.

This newsletter explains the “classical route” of converting co-ordinates....

Step 1: WGS84 Geodetic to WGS84 Cartesian

A point surveyed in the field is stored on the sensor as a WGS84 Geodetic co-ordinate. It is of course described in terms of Latitude (ϕ), Longitude (λ) and Height (h) above the ellipsoid (in this case the WGS84 ellipsoid). We shall consider a point with the following WGS84 co-ordinates:

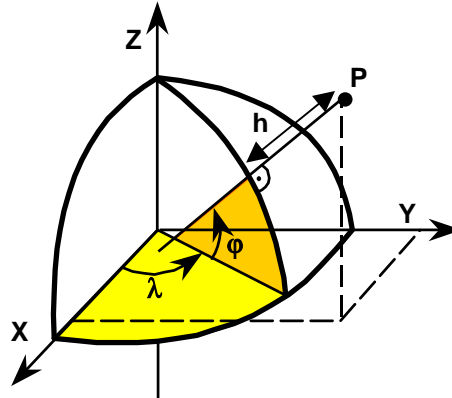
- WGS84 Lat = 48° N
- WGS84 Long = 10° E
- Ellipsoidal ht = 500m

Knowing the Ellipsoid and using standard algorithms it is possible to compute the corresponding Cartesian co-ordinates for this same point (described in terms of X, Y and Z). Applying these algorithms to our point results in these Cartesian co-ordinates:

- WGS84 X = 4211089.525m
- WGS84 Y = 742528.701m
- WGS84 Z = 4717247.902m

Notice how much easier it is to imagine on the Earth where a point with Geodetic co-ordinates is than Cartesian co-ordinates. Would you have known that the co-ordinates 4211089.525m, 742528.701m, 4717247.902m relate to a point on the ground near Heerbrugg?

The next diagram shows the relation between Geodetic and Cartesian co-ordinates.



It is now clear we need an ellipsoid to convert between Geodetic and Cartesian co-ordinate and back again.

However to get to local grid co-ordinates, we firstly need to get to Local Cartesian co-ordinates.

Step 2: WGS84 Cartesian to Local Cartesian

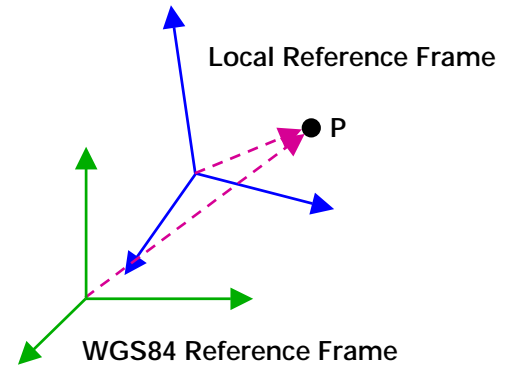
Here a Transformation is normally required. A transformation consists of up to 7 Parameters. These parameters may already be known, or may need to be computed. A full 7 Parameter Transformation consists of 3 shifts (dX, dY and dZ), 3 rotations (Rx, Ry, Rz) and a scale factor. However, it is quite often the case that not all of these parameters are required.

Using standard algorithms with the appropriate transformation parameters, it is possible to convert between WGS84 Cartesian and Local Cartesian co-ordinates.

But what really is the difference between Local Cartesian co-ordinates and WGS84 Cartesian co-ordinates? They both describe the location of the same physical point, so why are the numbers different? It is because the origin and/or the orientation of the two reference frames (the WGS84 and the local reference frames) are different.

The transformation parameters actually mathematically describe these differences.

The diagram below shows two different reference frames with different origins and orientations.



In our example we will use a 3 Parameter Transformation where dX=100, dY=-200 and dZ=300. This results in local Cartesian co-ordinates of:

- Loc X = 4211189.525m
- Loc Y = 742328.701m
- Loc Z = 4717547.902m

Step 3: Local Cartesian to Local Geodetic

As described earlier, an Ellipsoid is needed to convert between Cartesian and Geodetic co-ordinates. Because we are now converting “on the local side”, between local Cartesian and Local Geodetic, this can be called the “Local Ellipsoid”.

In this example we will use the Bessel ellipsoid. Using exactly the same algorithms as in Step 1 (but with a different ellipsoid) we can compute Local Geodetic co-ordinates. In our example we obtain the Local Geodetic co-ordinates:

- Lat = 48°00' 0.82316"N
- Long = 9°59'49.66165"E
- Ellipsoidal ht = 1468.783m

To be continued.....