Coordinate-Calculator

for the simulation program BAHN

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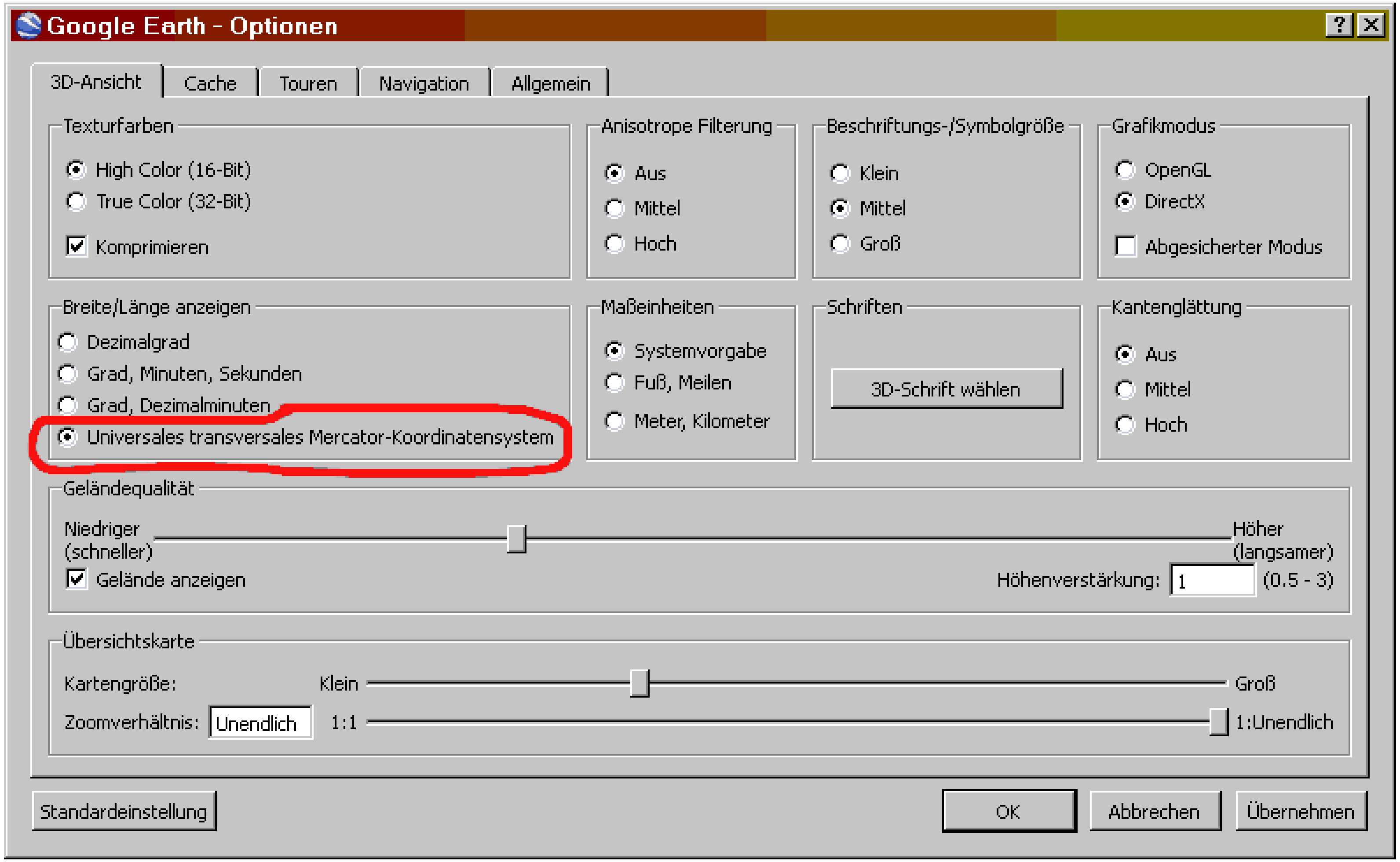
This table calculates geographic coordinates of the Universal Transverse Mercator coordinate system into coordinates for a BAHN network. Thus it is possible to construct the real model on earth as a model railroad true to scale in a PC. To display the coordinate data in Google Earth correctly it is necessary to activate the corresponding display in the menu Tools / Options:



Quelle: GoogleEarth

The table was created with OpenOffice 3.4.1 and saved in Microsoft Excel format 5.0.

The coordinate system using the example of Google Earth

The UTM coordinate system projects the curved surface of the earth on to a cylinder, which can be represented unrolled as planar surface, and divides it vertically into 60 zones with a width of 6°. The zones in turn are divided into sections, which are marked by a letter. The display of the geographical coordinates are not in degrees but in meters, which facilitates the use for BAHN very much. Further explanations concerning the table follow below, detailed information see, for example in Wikipedia (Universal Transverse Mercator coordinate system).

The coordinate data are referred to horizontal as Easting and vertical as Northing. It is displayed in the format

`Easting : 32 U xxxxxx,?? m E`

32 is the number of the zone (Germany), U is the brand of the vertical section, xxxxxx is in meters.

`Northing: 5yyyyyy,?? m N`

5 is the distance from the equator in million meters, yyyyyy is in meters.

Describtion of the table

For calculations you need the 6 digits before the floating point, that means the positions of "xxxxxx" in column A and "yyyyyy" in column B. However, when a network north of Glückstadt is built, the Northing value changes from the 5-million-meter-range into the 6-million-meter range - then the entry in column B must be "1yyyyyy".

	A	B	C	D	E
1	Meter		64	X	Y
2	500000	710000	15,6250	16384	16384
3	500000	710000		500000	
4					
5					
6					
7					
8					

The highlighted green cells are the input fields to customize the table to calculate the BAHN coordinates. The (current) values are as follows:

A3 and B3: Center of UTM zone
C1 : Scale (default value for BAHN 3.xx: 64 items / km)
D2 and E2: Origin of scenery in BAHN (default value for BAHN up to 3.86)

The word "Meter" in A1 may be replaced ie by the name of the zone for which the calculations in the five columns A-E are carried out. This facilitates the distinction when processing in columns F-J or K-O data for adjacent zones.
Default values for BAHN 3.87: 32768,32768 as origin and for BAHN 4.xx: 128 (items / km) and 65536,65536 as origin.

In cell C2 the calculated edge length of an element will be shown based on the free selectable scale in C1.

The entry of Google Earth values are into columns A and B starting at row 5. All information about A-E shall apply to the columns F-J and K-O. Column C is for comments. Columns D and E show the calculated BAHN coordinates.

Adjusting the table

For larger networks it is probably wise to put the origin, ie the point which you start to build around, on to a coordinate so that the planned network fits into the working area of BAHN. Therefore the first step is to adapt the table. Let’s take my hometown Hamburg as example. This is the starting area of my Germany railroad net. Hamburg is located in the north, and if I still want to reach Dresden, then I need to consider when planning the BAHN coordinates:

	A	B	C	D	E
1	Zone 32		64	X	Y
2	569917	934194	15,6250	13688	10191
3	566788	934194		569917	
4					
5					
6					
7					

Seeking a distinctive point in Google Earth and transferring the values into the table:

```
A3 Easting  566788
B3 Northing 934194
```

This is the octagonal pavillon next to the railway station hall.

Defining the origin for BAHN:

```
D2 = 13688
E2 = 10191
```

Now the position of Hamburg in the scenery is approximately matched to the geographic location in Germany.

Note: Sometimes it is mistaken in setting the origin, and part of the great model would not fit into the work surface. Then you must move the scenery around a difference Xd,Yd. You have to add these differences to the values in D2 and E2, and everything is right again. Of course existing data in the columns A and B will be calculated again.

Transition from one zone to an adjacent zone

The zones, rather the relevant section U, are almost identical, and at comparable positions they have the same Easting values: The lowest in the West, the highest in the East. To capture Germany completely from east to west we have to change from zone 32 to zone 33. For this zone the specifications in the cells A3, B3, D2 and E2 are useless, they must be created new. Probably the values in A-E are needed later, therefore we use the columns F-J now.

When on Google Earth view menu, the grid is turned on and we move on the basis of this grid on the boundary of the zones 32 and 33 from north to south, then the grid line appears as a vertical yellow line - the "N" in the Navigator right above should be positioned exactly in the north. The Easting values increase, and that means actually to build a diagonal line from top left to right down in BAHN. But the formulas of the table are based to the UTM-representation, and hence the BAHN coordinates are perpendicular among themselves.

Using the examples Bützow in Meck-Pomm and Halle(Saale) the work steps are described, with which the columns F-J (for Halle(Saale) K-O) will be prepared for processing data from zone 33.

```
The easternmost values for Bützow: Easting 697382, Northing 969704, BAHN-X = 22538, BAHN-Y =  7918
The easternmost values for Halle : Easting 708345, Northing 706559, BAHN-X = 22538, BAHN-Y = 24760
```

(see upper part of the graphic)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Zone 32		64	X	Y	Meter		64	X	Y	Meter		64	X	Y
2	569917	934194	15,6250	13688	10191	500000	710000	15,6250	16384	16384	500000	710000	15,6250	16384	16384
3	566788	934194		569917		500000	710000		500000		500000	710000		500000	
4															
5	697382	969704	Bützow Bahnsteig	22538	7918										
6	708345	706559	Halle Tennisplatz	22538	24760										
7															
8															
9															
10															

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Zone 32		64	X	Y	Zone 33		64	X	Y	Zone 33		64	X	Y
2	569917	934194	15,6250	13688	10191	291803	969704	15,6250	22538	7918	291796	706559	15,6250	22538	24760
3	566788	934194		569917		302618	969704		291803		291654	706559		291796	
4															
5	697382	969704	Bützow Bahnsteig	22538	7918	302618	969704	Bützow Bahnsteig	22538	7918					
6	708345	706559	Halle Tennisplatz	22538	24760						291654	706559	Halle Tennisplatz	22538	24760
7															
8															
9															
10															

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Zone 32		64	X	Y	Zone 33		64	X	Y	Zone 33		64	X	Y
2	569917	934194	15,6250	13688	10191	291803	969704	15,6250	22538	7918	291796	706559	15,6250	22538	24760
3	566788	934194		569917		302618	969704		291803		291654	706559		291796	
4															
5	697382	969704	Bützow Bahnsteig	22538	7918	302618	969704	Bützow Bahnsteig	22538	7918					
6	708345	706559	Halle Tennisplatz	22538	24760						291654	706559	Halle Tennisplatz	22538	24760
7															
8						388038	819546	Berlin Siegessäule	28538	17528	388038	819546	Berlin Siegessäule	28538	17529
9						604817	342741	Wien Donauinsel	42128	48044	604817	342741	Wien Donauinsel	42128	48044
10						712809	596927	Polen A4/ E40	49187	31776	712809	596927	Polen A4/ E40	49187	31776

In determining the values the cursor in Google Earth is located just left of the grid line, so we move it a tad to the *right*, and we get the westernmost Easting of zone 33:

```
302618 for Bützow
291654 for Halle(Saale)
```

The Easting is entered into F3, the Northing shall be taken from column B and put into G3. As X and Y coordinates for BAHN we transfer the calculated values of the columns D and E directly into the cells I2 and J2
(see middle part of the graphic)

Well done, that's it, now there is nothing contrary to the further expansion of the scenery in easterly direction. For a change in a westerly direction, from zone 32 to zone 31, is to proceed analogously: Determining the westernmost Easting of zone 32, then move the cursor a very little bit to the *left* and read the easternmost Easting of zone 31.

In the lower part of the graphic I have entered some additional data in dependence of the change in Bützow and Halle(Saale) to show that it is irrelevant for the calculation of BAHN coordinates on which latitude the change takes place - the calculated X values for BAHN are identical.

The last entry for the E40 in Poland is at the crossover from zone 33 to zone 34 With the procedure described above the table can be set up for further processing of data for eastern Poland.

At least the entries for Vienna and Poland give an idea of: With BAHN 3.87 and higher - coordinates calculated by this calculator - the scale reproduction of almost the entire Central European ICE network is possible - even a nice job ...

Yet another note: With this calculator it is in principle possible to modify the sections T and V, but as the formulas are optimized for Section U, the distortions increase in an intolerable degree level the further you move away from the blue center line.

Additional Comments

You might know my old coordinate calculator from http://www.das-bahn-forum.de/bahnforum/ and perhaps you might ask for the innovation in this calculator. Well, mostly I have corrected an error thinking that I had not taken into account regarding the change from one zone to another.

As well known for quite some time, the earth is not flat, but a sphere. That’s why some problems exist to present the surface as far as possible as a flat surface without distortion. Humans are used to see the surface in a plane in which all latitudes have a horizontal orientation. Let's look at the next graph:

Quelle: GoogleEarth

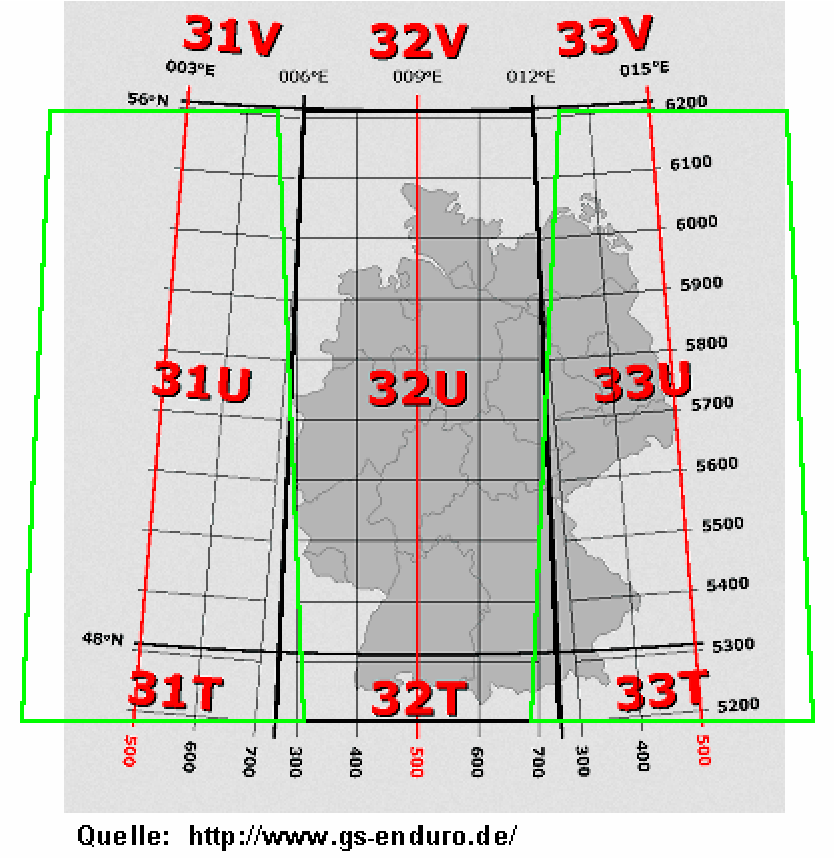
This image transmitted to the entire northern hemisphere would yield a disk for the representation of the surface, however, then the latitudes are no longer parallel and horizontal. The brilliant cartographers have found a way to display the UTM coordinate system in good manner. The meridians are placed vertically so that they match the latitudes and form rectangles. The disadvantage of this method: The area between the meridians is stretched from the equator towards the poles, thus distorted.

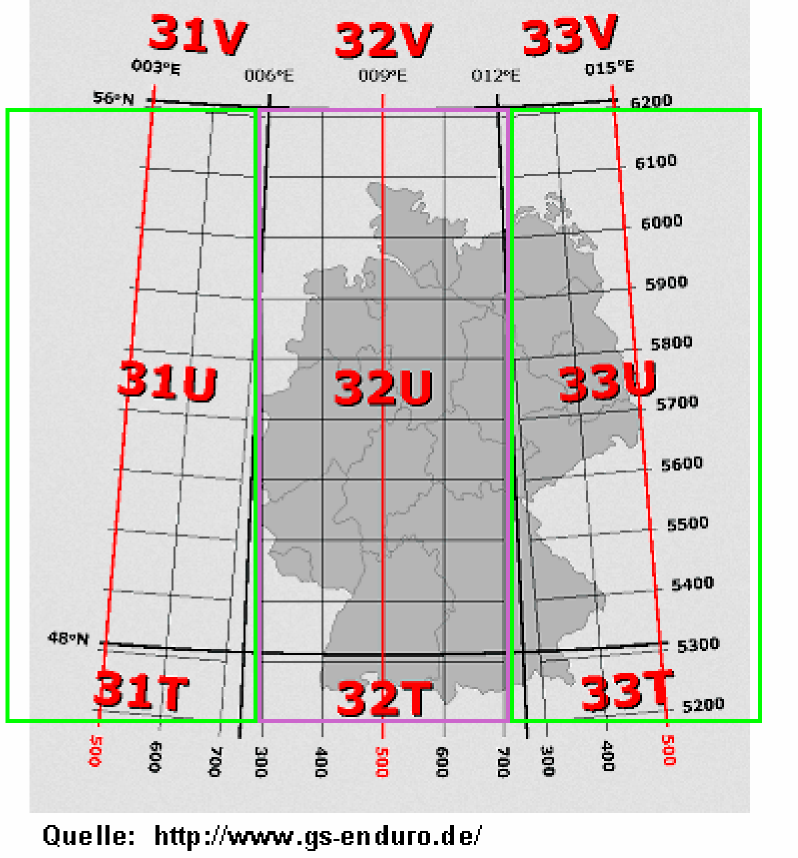
The Earth's surface is from 80° south to 84° north strip-divided into 60 vertical zones, each 6°. Each zone in turn is divided into sections that are designated with a letter.

I have recreated the mentioned method in the formulas in my calculator. But I lack the brilliant Knoffhoff of cartographers, and therefore my formulas are really relevant only for the section U of a zone - and a little south of it. For this area (see dashed line in the graphic above) I have determined empirically some constants which are significant for the formulas.

The blue line is the horizontal centerline of the area with the largest width of the BAHN coordinates - with a zero point 16384.16384 the X coordinates range from 3059 to 29709. To the north, the area will be stretched and swaged south of it - the edges of the area in BAHN are thus perpendicular, and that allows a cross-zone processing of the UTM coordinates.

The following graphic illustrates on the left once more the problem of the old coordinate calculator when creating a cross-zone scenery, and shows on the right the resulting solution: The latitudes are converted to horizontal values, and the edges of the zones abut flush against one another.





The transition is approximately at the center. It is recognizable: Just north and south to the transition point the surfaces of the zones will be replicated even without large over processing, but then they drift apart in the north and overlap in the south.

The solution: Just north of the crossover point the areas are stretched and south of it swaged. So the section of U zones are transformed to a rectangle, joining together the zones is seamless from north to south.