MANUAL for KmsTrans

Contents

The Program KmsTrans

KmsTrans can carry out Coordinate Transformations between different geodetic coordinate systems including height transformations between DVR90 and DNN heights (new and old Danish Height Reference System).

The program is based on the KMS coordinate transformation system written in ansi-C. The program is written for the Microsoft Visual C++ Compiler, and is designed to run on a Windows platform.

Short character strings (so called MiniLabels) are used for indicating the different coordinate systems. These labels can be read by the program and by humans as well. It is highly recommended users of KmsTrans to read the help topics describing *MiniLabels* and *File Formats*.

The user interface of the program consists of a series of dialog boxes. From the Start Dialog there is access to the other dialogues where the transformations and calculations can be performed. A list is given here:

Start Dialog ->

File to File Dialog (Transformation of files containing coordinate lists)
Keyboard to Screen Dialog (Typed coordinates are transformed and written on the screen)
Bessel-Helmert Dialog (Calculation of 'directions and distances' or 'coordinates')
DistDir Dialog (FileToFile Bessel-Helmert)
Polygon Area Dialog (Calculation of area for a polygon)
Convert Units Dialog (Conversion of different units)
Geoid Setup Dialog (Connecting the program to geoid models and Height Diff Table)
KMS Matrikel (Tiny version of transformation dialogues)
(Writes info on MiniLabels)

The program is designed for the transformation of coordinates within the regions of Denmark, Greenland and the Faroe Islands. The different local systems used in these regions are connected to each other and to a wide range of global systems. Outside the three regions only the global systems are available. Geoid Models are connected to the program for the transformation between heights above the ellipsoid and heights above the geoid. These models are of low accuracy outside the 3 regions.

Start Dialog

The buttons to the left in this dialogue offers access to different sub dialogs where Transformations carried out.

In the Utility Dialogs you can calculate Distances, Directions and Areas.

Coordinate Transformations:

Keyboard to Screen:
Input coordinates are typed via the keyboard and results appear on the screen

File to File:
Input from file and output to file.

Utilities:

Bessel-Helmert:
The distance and azimuth is calculated from two sets of coordinates or from one set of coordinates is another set calculated from the distance and azimuth. This dialogue uses input from keyboard and writes the output to the screen

DistDir:
This dialogue performs Bessel-Helmert calculations of distances, directions and coordinates using input data read from files, and writes the result in an output file.

Ploygon Area:
The area of a polygon is calculated on the ellipsoid. Input is read from a file containing a list of coordinates for the vertexes of the polygon. Sides of the polygon are the geodesics connecting these vertexes.

KMS Matrikel:
is a tiny version of the transformation dialogues: Keyboard to Screen, File to File.

Setup:

Geoids:
In the Geoid Setup Dialog you can select the PATH to the directory containing the geoid models and the file "manager.gde".
This PATH is also needed for the proper function of the system of MiniLabels.

See also *Geoids*.

GeoDoc:

Pushing this button will write a documentation of the MiniLabel system in the file:
C:\TMP\GeoDocData.txt.

Help:

Each dialogue in KmsTrans contains a Help Button to be used for context sensitive help.
Context help for the single controls is not implemented.

File to File Transformation Dialog

In this dialog box, the user can carry out "File to File Transformations": the program can read files containing coordinate lists, and write the transformed coordinates in other files. Different file formats can be used: KMS Standard, SHAPE, DSFL, GTX and SDL. The KMS Standard format may be modified in several ways, making many formats acceptable for the program. This is done by the check buttons in the box: "*Modifications to KMS Format*".

Before using this dialogue, you should try out the *Keyboard to Screen Transformation Dialog* in order to get acquainted with the *minilabel* system used for indicating the coordinate systems. Also you should read the help topic describing *File Formats* where examples of different formats are given.

The order in which the many possibilities of selections in the dialogue are carried out is not very critical. Still it is recommended to start out choosing the region (Denmark, Greenland or the Faroe Islands): this will change the content of the drop down lists used for selection of coordinate systems. After the selection of region, you should select format in the radio button frame marked "File Format" - and then proceed to the selection of in- and output files via the buttons in the upper left of the dialog box.

If the input file contains a label (minilabel), this will be used as a description of the input system. If no coordinate label is found, the user is prompted for a specification of the input system; - or you may uncheck the "Label in File" button.

The output label box (marked "Output System") should be filled out, either by selection from the drop-down-list or by manual editing.

Some coordinate systems can't be described by a short minilabel because more parameters are needed. Such systems can be selected via the bottom items in the drop down lists (marked "Label from File"). This selection will open a File-Open-Dialog where you can select a file containing the correct label. Alternatively a minilabel may be written in the textbox when the text is not too long; - else it is recommended to use "label from File".

Use the buttons marked "Change H" to change the height systems - or for selection no heights.

More Input Files may be selected. To deselect all push the button "Flush Infile List". When more files are selected the Otput Files will become the same name as the Input File; - but in another directory pointed by the user in stead of an Output File name.
This option may be used by one input file also when checking the "Same Name" button.

Just like in the Keyboard to Screen Transformation, you can - via radio buttons - select which *units* are to be used for in- and output of geographical coordinates.

In the drop down list marked "Accuracy for the writing of coo" you can choose with which accuracy the output coordinates will be written.
NB: this selection will not influence the accuracy of the transformation calculations.

When "Show for Output System (as comment): Scale and Meridian Convergence" the values will be calculated and given for the Output Coordinate System.

Modifications to the selected file format can be made. The *modifications* are described in the topic *File Formats*. Like many of the other selections you are making in the program, these modifications are stored in the INI file for the program, and are preselected the next time you are running the KmsTrans.

Having made the selections of files, coordinate systems and the other parameters describing your task, you can carry out the transformation by activating the button marked "Execute"

After the transformation a small box will appear below the execute button, showing the number of transformed coordinate sets.
If the program has detected errors, the number of those will also appear

FILEVIWER:
To the right in the dialog box, you will find a button marked "View". This button gives you access to a file viewer where you can inspect the content of the in- and output files - and also of the log file where a more detailed description of the transformation(errors) are written. Only the first 1000 lines are shown.

Print Log File:
To the right in the dialog box, you will find a button marked "Print LogFile". This button gives you the possibility to print the LogFile.

Keyboard to Screen Transformation

Using the Dialogue:

In this dialogue for coordinate transformation, the input coordinates are typed on the keyboard "into" input edit boxes on the screen and the transformed coordinates are written (on the screen) in output boxes. Input Boxes are white, Output Boxes are gray.

The selections of region, coordinate systems, and units are made via different buttons.

The coordinates are transformed from the Input System to the Output System

Preparing the transformations in this dialogue, you have to select the coordinate systems: Input System and the Output System. This is done via the two Combo boxes to the left in the dialogue. These boxes have Drop down lists containing a choice of coordinate systems dependent on which region is selected. Therefore in order to have a suitable content of the Drop down lists, it is a good idea to start out by selecting the proper region:

Region:

The program is designed for transformation of coordinates within three regions:

1: Denmark
2: Greenland
3: Faroe Islands

The region is selected via the Radio Buttons in the middle left of the dialogue. This selection will cause the Drop down lists used for the selection of Coordinate Systems to contain systems "belonging" to the selected region.

Transformations involving local systems can be carried out only for positions inside one of these regions. Transformations between the global systems - UTM, Geographical, Cartesic etc are possible when the datum used is recognized by the program.

The selection of region only affects the contents of the Drop down lists in the Combo Boxes.

Coordinate Systems:

The two Combo Boxes ("Input System" and "Output System") in the left of the dialogue has predefined "MiniLabel"s in the static part of the combo boxes. (Se also *MiniLabels*.)

For writing the minilabels in the combo boxes you have several possibilities:

1. You can write the minilabel directly in the edit part of the box.
2. Select the proper label from the Drop down list.
3. If you can't find the label you want in the Drop down list, select a similar label and make corrections via manual edit.
4. The more complex minilabels (including extra parameters) can not be inserted in the combo boxes. Such labels have to be read from a file by selecting from the Drop down list the bottom item "Label from File" an "OpenFileDialogBox" will appear - here you can open the file from which the label will be read.

Heights:

Next to the two System Combo Boxes you will find the "Change H" (change height) buttons to be used for toggling the height systems. In this dialogue heights are always incorporated in the transformations. If you don't need the height, use an input (main) height of 0.0 and just ignore the slave (output) height. The "Change H" buttons toggles between some *Vertical Reference Frames* the region. Ellipsoidal Height refers to the height above the ellipsoid. Normal Height (N) is used where a proper definition of a Vertical Reference Frame is impossible.

For transforming the heights (normal heights to ellipsoidal heights or visa versa), the program is using geoid models. Although the KmsTrans package contains models of global coverage, only the models covering the three main regions have reasonable accuracy. For the three regions the estimated accuracy of the geoid models is:

Denmark	: 0.01 m
Greenland	: 0.50 m
Faroe Islands	: 0.02 m
Scandinavia	: 0.05 m
The Baltics	: 0.05 m

Outside these regions a global model is used. Here errors of 2 m can be expected.

Swap the Systems:

The button marked "Swap Main/Slave" below the combo boxed will switch the two systems.

Inserting the Main Coordinates:

When the combo box selections of coordinate systems are accepted by the program, you will see two text lines in the top of the dialogue, containing system descriptions. Also three white coordinate input boxes will appear (next to the "Change H" button).
This is where you supply the Main Coordinates, using mouse/keyboard/TAB/Arrows.
Normally the leftmost edit box is used for the first (north going) coordinate, the middle box for the second (east going) coordinate and the third for the height. Texts above the edit boxes indicate where to insert which coordinate. Some coordinate systems have the sequence (E, N) which is then signaled in the label of the input boxes.

The program responds to all changes in the coordinate input boxes: whenever the boxes contain a new set of acceptable coordinates, the transformation Input System -> Output System is carried out - and the transformed set of coordinates is written in the Output Coordinate Boxes (below the Main Boxes).

Units:

Normally geographical coordinates are inserted in units of Degrees, Minutes and Arc Seconds. For all the other systems, the meter units are used. For the geographical coordinates, you can change this unit selection by using the Unit Radio Buttons (appearing next to the Region Buttons when a geographical system is selected). For the input coordinates you can always override the unit selection by using unit-terminations.
More information concerning units for coordinates can be found in the topic: *Units used for Angles and Coordinates.*

Geoid Info:

In the lower left of the dialogue, two boxes marked "Geoid Name" and "Geoid Height" for the output system will display the name of the used geoid model and the geoid height for the position indicated by the Output Coordinates.
The Geoid Height is the height of the Geoid above the Ellipsoid. In the Geoid Height Box, the geoid is referenced to the ellipsoid from the datum of the OUTPUT system.

Errors:

If the program detects errors a report is given in the Info Window in the lower right of the dialogue.

Errors will occur:

- During the editing of the system boxes - when the content of one of the boxes isn't recognized as a label.
- When the Main Coordinates indicates a position for which the transformation can't be properly carried out.
- When geoid information can't be extracted from the models.

Bessel-Helmert

The Bessel-Helmert formulas can be used for calculating distances and directions on the ellipsoid.

Geodesics and Azimuths.

Ellipsoidal geometry is used. In this geometry the "line elements" are the Geodetic Lines (geodesics i.e. the shortest line from one point to another). The angles are angles between crossing geodesics.
Directions in ellipsoidal geometry are directions of geodesics.
From each point (except the north pole) on the ellipsoid the geodetic to the north pole is used as reference for other geodesics passing through that point: The direction of a geodesic in a point is called an Azimuth and is measured as the angle between the reference direction (towards north) and the geodesic. Note that the azimuth not only describes the orientation of a geodesic but also which direction to go.

When two points (Stn1 and Stn2) on the ellipsoid are connected by a geodesic, the azimuths of the geodetic connection in those points are called the "Forward" and the "Backward" azimuth respectively. The forward azimuth is measured in Stn1 as the azimuth towards Stn2. The backward azimuth is the azimuth of the geodesic towards Stn1.

For a setup of two points connected by a geodesic, you can use this dialogue to calculate unknown elements from given (elements).
The dialogue has two modes, each corresponding to the calculation type:

1. Based on coordinates to two points, calculating the ellipsoidal distance between these points and also the forward and backward azimuths.
2. From distance and direction (forward azimuth) from one coordinated point, calculating the coordinates to the other point.

Radio buttons in the lower left are used to toggle the mode selection.

Data:
Data are read to the dialogue via the keyboard - directed to the proper input boxes. Results of the calculations are written in output boxes.
Depending on the mode selection different boxes are opened for in- and output. The input boxes are white, the output boxes are gray.

Coordinate systems:
In both modes, you have to select the Main System - the system used for input of coordinates and for the calculations (ellipsoid parameters are taken from the Main System).

The Slave System is just used for mirroring the Main System coordinates in another coordinate system.

Just like in the transformation dialog boxes, the selections of Main and Slave Systems are done via the combo (pull down) boxes in the top left of the dialogue. Recall how the selection of region changes the contents of the drop down lists.

Having used the transformation dialogues (?) you are already familiar with the use and selection of *units* for coordinates in this program.

In the present dialogue two "new" groups of radio buttons are available, both concerning the azimuths: in the first group the default angle unit for the azimuths is set, in the second the angle unit for the output azimuths are written.

DistDir

This dialogue performs Bessel-Helmert calculations (of distances, directions and coordinates) using input data read from files, and writes the result in an output file.

Coordinate Box:
The Button labeled "Add Coordinates" is used for the reading of a coordinate list - the format of this list is the *KMS Standard Format.*

The "*Flush Coo List*"-button will clear the stored coordinates.

The button marked "*Select Units*" is used for selecting *units* for coordinates and angles.

The button marked "*Output File*" is used for selecting an output file.

The Dist/Dir Box:
The Button labeled "*Read Defining List*" is used for the reading a list of station numbers defining which distances and directions to be calculated. The stations should be present in the coordinate file. The format of the defining list given as an example:

```
#utm32_etrf89

7008 d
7003
7005
7009
71034
2001 d
3004
3010
4000
4999 d
4901
4902
-1z
```

As usual empty lines are skipped and the list must be labeled (although the content of the label is not used in this example).

The number list consists of one or several blocks, each block starting with a "d" terminated station number. The following numbers in the block indicate the objects - for each block the program calculates distances, azimuths and directions from the station to all the objects.

The Calc Coord Box:
The Button labeled "Read Polar Obs" is used for the reading a list of station numbers defining which distances and directions to be calculated. The stations should be present in the coordinate file. The format of the defining list given as an example:

```
#utm22_wgs84

7000 a
7100      500 m        20 00 00 sx
7101      700.0 m      50 00 00 sx
7102     1000 m        77 00 00 sx
7103        2 km       80 dg
8001 a
8101      300.07 m   122 22 22 sx
```

```
8102      444.44 m   133 22 33 sx
9900 a
9200      123.123 m   90 33 33 sx
9201      222.222 m  356 22 22 sx
-1z
```

The label of the task list is used for coordinate output.

The observation list consists of one or several blocks, each block starting with a "a" terminated station number. The following numbers in the block indicate the objects - for each block the program calculates the coordinates to all the objects.

Calculation of Polygon Area

In this dialogue you can calculate the "geodetic" area of a polygon.

Input:

A coordinate list, describing the polygon: each set of coordinates in the list represents one vertex of the polygon - the sides of the polygon are the geodetic lines connecting neighboring points. The list should contain a *minilabel* and be terminated with "-1z".
If the (polygon) list is not closed - the same set of coordinates for the start point as for the end point - the program will append a "closing point" to the end of the list.

Only the KMS Standard for Coordinate File Format can be used. If you need some modifications to the KMS Format, you may want to transform the format via the File to File Dialog.

Example of Input data:

```
#u32_etrf89

   1111         6200 km    500 km
   1112         6300 km    500 km
   3002         6300 km    600 km
   4004         6200 km    600 km
-1z
```

Calculation:

The area is calculated on the surface of the ellipsoid from the datum of the input coordinate system.

The geodetic lines are subdivided by points in small distance. These points can after a transformation to an equal area projection represent the projection of the geodesics with sufficient accuracy, making it possible to calculate the area via summation.

Error messages and results appear in the Info Box, and are also written to the output file.

NB:

> The polygon should be "simple": no side crossing over any other side. This "simplicity" is NOT controlled by the program.

Buttons:

Via the buttons marked "Select Input" and "Select Output" the files are selected. The output file will contain information of file names and coordinate systems, of the subdivision of the polygon sides and also here the result of the calculation (the polygon area) is written. Just like in the File to File Dialog the content of the in- and output files can be inspected in the file viewer (press the button marked *File Viewer* .

Convert Units Dialog

No much help needed here: Simply select the type of units you wish to convert and enter the value in the appropriate edit-box.

KMS Matrikel

This is a tiny version of the transformation dialogues: *Keyboard to Screen, File to File.*

Denne dialog kan

- “Enkelt Koordinat”: transformere et indtastede koordinatsæt fra et dansk koordinatsystem til et andet (dansk).
- ”Fil til Fil”: transformere en liste af koordinatsæt fra et dansk koordinatsystem til en andet.
- ”Sand Afstand”: Beregne afstanden mellem to indtastede koordinatsæt (korrigeret for skala).
- ”Sandt Polygon Areal”: Beregne arealer af en simpel polygon (korrigeret for skala).

Der findes desuden en mulighed for at sætte stien til *Geoide Biblioteket.*

Koordinatsystemer:
De tilladte koordinatsystemer er (i parentes er koordintrækkefølgen angivet):

```
utm32_etrs89  (N, E)
utm33_etrs89  (N, E)
dktm1         (E, N)
dktm2         (E, N)
dktm3         (E, N)
dktm4         (E, N)
s34j          (Y, X)
s34s          (Y, X)
s34b          (Y, X)
```

Transformation: Enkelt Koordinat:
Til venstre i ”Input System” drop down listen vælges hvilket koordinatsystem, der skal transformeres fra. Til højre i ”Resultat System” drop down listen vælge hvilket koordinatsystem, der skal transformeres til.
I ”Input Kotesystem” vælges om, der er koter i input; - og hvilke kotesystem der transformeres fra.
I ”Output Kotesystem” vælges om, der er koter i output; - og hvilke kotesystem der transformeres til.
I de tre hvide bokse til venstre indtastes koordinaterne som angivet og eventuel kote.
I de tre grå bokse til højre vises de transformerede koordinater som angivet og eventuel kote.
Fejl meddelelser kan forekomme i det nederste store vindue; - især når koordinaterne ligger uden for definitionsområdet.

Transformation: Fil til FIL:
I ”Input Fil” vælges den koordinat fil, der skal transformeres.
I ”Resultat Fil” vælges den koordinat fil, der skal indeholde resultatet.
KMS standard format benyttes i begge tilfælde.
Nogle modifikationer til KMS standard format kan foretages i ”Modifikationer til KMS format”.
Såfremt input filen *ikke* indeholder en MiniLabel, vil man kunne vælge det koordinatsystem hvorfra, der skal transformeres. I ”Resultat system” vælges det resulterende koordinatsystem.
I ”Input Kotesystem” vælges om, der er koter i input; - og hvilke kotesystem der transformeres fra.
I ”Output Kotesystem” vælges om, der er koter i output; - og hvilke kotesystem der transformeres til.
Fejl meddelelser kan forekomme i det nederste store vindue; - især når koordinaterne ligger uden for definitionsområdet.

Beregning: Sand Afstand:
Til venstre i ”Input System” drop down listen vælges hvilket koordinatsystem, de indtastede koordinater er angivet i.
I felterne til højre for ”Station 1” indtastes koordinaterne for det første punkt.
I felterne til højre for ”Station 2” indtastes koordinaterne for det andet punkt.
I feltet til højre for ”Sand Afstand fra 1 til 2” vises afstanden.
Fejl meddelelser kan forekomme i det nederste store vindue; - især når koordinaterne ligger uden for definitionsområdet.

Beregning: Sandt Polygon Areal:
I ”Input Fil” vælges den koordinat fil, der skal transformeres.
KMS standard format benyttes. Det kan angives om stationsnumre mangler; - samt om et enkelt mellemrum er anvendt som skilletegn.
I ”Resultat Fil” vælges den koordinat fil, der skal indeholde resultatet.
Når de nødvendige dele er valgt og afkrydset kan arealet beregnes ved tryk på ”Beregn Areal”.

File Formats

In the *File to File Transformation Dialog* the user can choose between several File Formats. This selection is valid for both In- and Output File: It is not possible to select input in one format and output in another. The present possibilities are:

1. KMS Standard format (including modifications)
2. DSFL Format
3. SHAPE Format
4. SDL Format
5. GTX Format

The KMS Format (with modifications) can be used for different "simple" lists where each point is represented by a line containing:

Point Identification
A set of Coordinates. (2D and optionally height; 3D)
Possibly a short comment which may be copied to the output.

In the dialogue, you can select between combinations of different modifications to the KMS Format. These modifications will be described later on this page.

A short description of the KMS Data Format:

NOTE: All text from a '*' character until a ';' character is skipped!

KMS Data Files are organized in data blocks. Each block has a header, describing which kind of data the block contains - thereby telling the program how to read the block.

The data are most often lists of coordinates or observations (representing measurements of angles, distances, vectors etc).
The header contains a MiniLabel, the first character of which is '#'. The rest of the MiniLabel is a string containing the block description. A user of the KmsTrans program should know how to use the *minilabel-system*.

Taking input from a KMS Data File, the program starts searching for a MiniLabel: it looks for the character '#'. In case this character is not found, the file contains no label and a warning is sent to the user. If the '#' is found, the program tries to recognize the following characters as a label, and having "understood" the label, it is decided whether the data in the block should be read or skipped. If this decision is for reading, the reading goes on until a data block termination (or end-of-file) is met.
The termination marks the end of the data block. Coordinate Blocks are terminated by a line starting with " -1z", observation blocks are terminated by a line starting with "-1a". Having read (or skipped) the data block, the program starts looking for the next MiniLabel.

Comment texts in the data (texts meant for 'human reading') will be ignored by the program if they are placed outside the blocks (before the first MiniLabel, or after a block termination line but before the following MiniLabel, or after the last block termination).

As the present program is designed for coordinate transformation (observation data will be skipped), the following description will concentrate on KMS Coordinate Data File:

<Any Text>
#<Coordinate MiniLabel>
<Coordinate Lines>
<Coordinate List Termination>
<Any Text>
#<Coordinate Minilabel>
<Coordinate Lines>
<Coordinate Block Termination>
<Any Text>

Any Text:
The program will skip any texts (one or more lines) outside the data blocks. The start label character ‘#’ is illegal in "<any text>". If the program finds the '#' character here, it will try to recognize the following string as a MiniLabel - and this may cause a program error.

Coordinate MiniLabel:
The character '#' marks the start of a MiniLabel. In this case (starting a coordinate block) the MiniLabel should describe the coordinate system, the height system and the datum for the coordinates contained in the block.

Coordinate Lines:
Each Coordinate Line contains the coordinate information for one station (point). The syntax for a coordinate line is :

<NewLine><SationIdentification><sep><Crd1><sep><Crd2>[<sep><Crd3>][<sep><Comment>]

The important elements are the Station Identification and the Coordinates. These elements are separated by the separator elements <sep> which can be either TAB characters, comma or double spaces < >< >. A single space (a < > (character value 32) having no < > as neighbor) will in the KMS Standard Format not be recognized as a separator: single spaces may occur inside Station Id's or Coordinates. As one of Format Modifications, the user can tell the program to interpretate single spaces as separators.

Station Identifications:
Most often the Station Identifications are just simple numbers, but some other types of Id.s can be used as well. The Id's are read by a routine also designed for the more complicated Id' used in the danish station numbering system. Examples of 'legal' Id's are:

```
1001        (simple number)
20.345      (number and sub number)
134-14-12   (danish station number)
134-14-12.5 (danish station number and sub number)
BANAN       (name: short string of upper-case letters)
```

Other ID-types may be used: in one of the modifications you can select the Station Id Element to be read as a string (max 11 chars).

A coordinate list without Station Id's can be transformed via the "No Station Numbers in Input" format modification.

Crd:
Coordinates:
NB: Crd1, Crd2 is in some systems Northing, Easting and in others Easting, Northing. This is usually signaled in the coordinate description. If a list has a wrong sequence Crd1 and Crd2 may be swopped on input (se *modifications*).

If the Coordinate MiniLabel indicates a list containing 3D coordinates each coordinate line should contain 3 coordinates, otherwise only 2 is needed. The coordinates are (decimal) numbers, which may be terminated by an Unit Type Termination telling in which units the coordinate was written. If no Unit Type Termination is found, the coordinate is expected to be in default units (for geographical coordinates normally sexagessimal degrees, minutes and arc seconds, and for other coordinates decimal meters).
Important: Recall that double spaces always will terminate an element (here a coordinate). Single spaces are allowed inside coordinates to increase the readability:

For example 100 degrees 3 minutes and 13.3 secs may be written:
`1000313.3sx` or `100 03 13.3 sx` but not `100  3 13.3 sx`
(in the last example the double space will terminate, and the result of the reading will be : 1 min and 0 sx when sx is the default terminator)

More about Unit Types in: *Unit Types*

Comment:
After the termination <sep> of the last expected coordinate in the line, a comment may follow. The comment may be copied to the corresponding output line. In case of 2D lists including the height information the height information will also be copied to the output.

Decimals:
The accuracy for the writing of transformed coordinates to the output file can be selected by the user. The default value for this accuracy (0.001 m) can be changed via the edit box marked 'Accuracy for the writing of coo'. Taking the Unit Selection into account, the program calculates the number of decimals needed.

SHAPE Format:
The ESRI SHAPE format may be transformed to an ESRI SHAPE format. When no .prj input file is found the input coordinate system may be set in the “Input System” Drop down list. A .prj file is written in the out directory. All files belonging to the input SHAPE file are transformed to the output files/directory.

DSFL Format:
The DSFL Format is an example of a more complex file type containing coordinate information. In a DSFL File, map data are represented via points, lines, polygons, curves etc. - these elements are described by coordinates and directions. When transforming a DSFL File, also the directions (referring to the coordinate system) have to be transformed.

SDL and GTX are both simple formats (one point pro line) which are seldom used any longer.

Examples of input files:

Ex 1: Coordinate list containing minilabel and geographical WGS84 coordinates:

```
This comment - preceding the first MiniLabel - will be skipped by
the program.
The following MiniLabel indicates the list is containing
geographical coordinates in datum WGS84. The underscore character
'_' separating the sub strings for coordinate system and datum
tells the program that the list is containing no heights

#geo_wgs84

   1001    81 33 44.456 sx      -14 22 44.321 sx
   1002    82 42 12.111 sx      -13 11 32.876 sx         comment
-1z
```

Ex 2: UTM-coordinates and ellipsoid heights:

```
#utm32Eed50

102-22-003     6 123 432.456 m       501 987.351 m       77.9 m
103-33-102     6 102 444.231 m       499 821.345 m     102.21 m
-1z
```

Ex 3: Geographical coordinates and Mean See Level Heights (Normal Heights):

```
As in this list the coordinates have no unit termination, the
program will assume the coordinates to be in "default-units". For
geographical coordinates that is normally sexagessimal degrees,
minutes and decimal arc seconds (select sx).

#geoNwgs84

101      81 22 44      -12 21 33        333.123
102      71 33 55      -12 22 34         33.981
-1z
```

Modifications to the KMS Standard Format

Via the format modification check boxes in the *File to File Transformation Dialog*, you can toggle (On/Off) a number of modifications to the KMS Standard Format in order to make the program use formats suitable to your data.

1: Station numbers in input: (standard ON):
If this box is unchecked (Off) the program expects no Station Identifications in the coordinate lines.

2: Stn numbers as strings (standard OFF):
When ON, the Station Identifications are read as character strings, making it possible to read also Id's not acceptable by the KMS Reading Routines.
When Off: the Id's are read by the KMS Standard Routine.

3: Single space terminator (standard OFF)
ON: single space (char < > (value 32)) is regarded as terminator for Station Id's and for Coordinates.
OFF: Single spaces are skipped by the reading routine. Such blind single space character 'inside' Id's and coordinates can be used to make the list more readable (for humans).

4: Copy Main Coordinates to Slave List (standard OFF)
ON: In addition to the transformed coordinates, also the corresponding input coordinates are written to the output file.
OFF: The Input Coordinates are NOT written to the output (slave) file.

5: Coordinate units in Slave File (standard ON)
ON: Output Coordinates are suffixed by unit indications.
OFF: No unit suffix to output coordinates.

6: Spaces in Slave File (standard ON).
ON: Station Id's and coordinates are written including (blind) single spaces in order to increase the readability.
OFF: No single space 'inside' Station Id's and Coordinates.

7: Copy comments: (standard ON):
ON: Texts in the coordinate lines - after the last (expected) coordinate are considered comments and are copied to the output lines.
OFF: Such texts are skipped.

8: Label in Slave File (standard ON)
ON: Each block of coordinate lines written to the output is preceded by a MiniLabel and terminated by a Block Stop Line (Station Id: -1z).
Prior to the first MiniLabel a header is written, describing the Input and Output Systems.
OFF: The Output List contains coordinate lines only.

9: Swop Input x/y: (standard OFF):
In the Standard Format the North/South going coordinate precedes the East/West coordinate.
ON: Input Coordinates swopped : East/West coordinate first, followed by the N/S coordinate.
OFF: Standard order of input coordinates: N/S followed by E/W coordinate.

10 Swop Output x/y: (standard OFF):
Toggling the order of the OUTPUT coordinates.

Geoid Setup

KmsTrans uses geoid models in calculations involving the geoid: in transformations between normal heights (referenced to the geoid) and ellipsoid heights (heights above some reference ellipsoid).

A geoid model consists of a binary file containing geoid heights in grid; usually a geographical. Each model covers a part of the earth, local models can be of high density and accurate, the more or less global models are normally of low accuracy having large grid constants.

The program uses a set (2-10) geoid models. When the geoid height for a (coordinated) point is needed, the "best" model is selected. For this "best model selection", a priority list is used. The list is situated in the file "manager.tab", and this file the program must be found in the directory containing the geoid model files.

Often the location of a point is covered by several (overlapping) geoid models. In the priority list, the models are placed according to their expected accuracy - high accuracy-models at the top.

Looking for the geoid height for a point, the program starts from the top of the priority list and picks the first model covering the location of the point.

Setup:
In order to connect KmsTrans with the geoid models, the program has to be informed where to find the manager file (and the models). This is done in the “Setup” box by pushing the button marked "Geoids”. A new dialogue appears giving the status of the Geoids. Activating the button “Press here to select the Geoid Directory” will open a "FileOpenDialog" where the manager.tab file should be opened. At return from the "FileOpenDialog” the success of the operation is shown by a list of geoid names available.

The path for the manager file (where also the geoid models and height diff table should be located) is stored in the programs INI-file for later runs of the program.

Se also *The Geoid*.

The Geoid

The Geoid is an idealized mean tidal sea surface extended below the land surface. The Geoid is defined as a surface having the same potential in the gravity field of the earth. The height of the Geoid is 0.0 m in the vertical reference system.

When point is stated to have the height X m this means that the point is situated X m above the Geoid. The distance is calculated along the plumb line which is perpendicular to the geoid. The plumb line has actually a very small curvature which is not taken into account for practical purposes.

Although the Geoid is a fairly smooth surface it do not have a simple geometrical shape therefore is it more convenient to make (accurate) geodetic calculations on an ellipsoid of revolution. Before year 2000 the International Ellipsoid 1924 (also named Hayford 1924) was widely used. In the different reference frames of each country the ellipsoid was placed different to the neighbouring country (Datum definition) so the geoid would also relative to the ellipsoid be placed different. This fact has made coordinate transformations very difficult until the GRS80 ellipsoid was defined and now globally used in satellite based coordinate systems.

Before the satellite base coordinate systems was introduced the ellipsoid was usually placed so that it to a high degree coincided with the Geoid. Then the geoid height was not take into account. The ellipsoid in the satellite base coordinate systems is placed with the zero point coinciding with the centre of masses of the earth. The geoid height is therefore varying from -115 m to + 65 m below/above the ellipsoid then it is necessary to include the geoid height in tha geoidetic calculations. When doing sattelite positioning the coordinates are true 3D coordinates which are naturally converted to geographical coordinates and the height above the ellipsoid. The ellipsoidal height is converted to *Vertical Reference Frame* heights by subtracting the geoid height.

KmsTrans uses three high precission geoid models to cover Denmark, The Faroe Islands and Greenland. The Scandinavia is Furthermore covered by a geoid model of lover accuracy and the entire earth is covered by a global geoid

KmsTrans must know the Geoid Directory. This is done in the *Geoide Setup Dialog.*

Coordinate systems and Datum

Coordinatsystems:

KmsTrans transforms coordinates of a Geodetic Coordinate system (“input system”) to coordinates of another system (“output system").

The geodetic coordinate system is defined trough three entities:

1. Projection coordinate system.
2. Datum
3. Vertical Reference Frame

Projection coordinate systems:

The classical geodetic observations are distances, angles between stations and astronomical observations from a station to stars. The purpose is to describe the relative position of the stations in a geometrical coordinate system.

The curvature of the earth implies that 3D geometry must be used. The calculations could then be made in either a 3D cartesic coordinate system or on a geometric surface which approximates the surface of the earth well. Such a geometric surface is traditionally chosen to be an ellipsoid of revolution. These calculations are somewhat complicated. Therefore have some mappings of the ellipsoid to the plane been designed and the calculations in the projection becomes easier to perform by introducing corrections to the observations for the curvature of the earth.

The 3D cartesic coordinate system is having its ZERO point in the centre of masses of the earth and oriented with the Z-axis to the North Pole (along the rotation axis), the X-axis to the zero meridian and the Y-axis to the 90 degree meridian.

The original 3D cartesic coordinates may the be represented by a 2D geographical coordinate on the ellipsoid or a 2D projection coordinate plus the height above the ellipsoid.

Many mappings have been designed but all projections will to some degree distort the geometry. Some mappings preserve the angles; - others preserve the distances; and some preserve the geometry locally. The most used geodetic mappings are conformal mappings which preserve the geometry locally.

The Mercator mapping is an example of a conformal mapping which preserves the geometry at equator but gives bigger distortions of distances the higher latitude. The geographical coordinate longitude and attitude lines are however perpendicular anywhere.

Some examples of mappings and their area of preserved geometry:

UTM:	The central Meridian (depending on the zone).
Conformal conic:	Parallel of latitude.
Mercator:	Parallel of latitude (depending on the scale).
Stereographic:	The North Pole or the South Pole.

The measures of the distortions are given in the Meridian convergence and scale (Se *Keyboard to Screen* or *File to File*). The Meridian convergence in a point is the angle from the Longitude line trough the point to the North axis of the mapping trough the point. The geometry is preserved when the Meridian convergence is ZERO and the scale is ONE.

Datum:

The datum defines:

- the shape of the ellipsoid though definition of the flattening and the main axis of the ellipsoid (or other appropriate parameters).
- the position of the ellipsoid.

When the datum is based on satellite observations the centre of the ellipsoid coincides with the ZERO point of the cartesic coordinate system (centre of masses).

In elder datum the ellipsoid was commonly placed to be parallel and close to the mean sea surface giving some bigger translations and rotations to the satellite base coordinates systems. The so called 7-parameter translation is determined on the values of two sets of coordinates in the two datum to the same stations. The translation may therefore be made with limited accuracy only.

Note: The ellipsoidal heights in two such datum are different for the same point.

Vertical Reference Frame:

Is descibed in the *Vertical Reference Frames.*

Vertical Reference Frames

A geodetic Vertical Reference Frame (VRF) consists of a (large) number of so called Height Fix Points (Benchmarks) distributed over an area such as a country, a part of a country or maybe a whole region - like Western Europe. Via measurement of height differences between neighboring points all points are connected, somehow a Height Zero level is chosen, and the "height" of each point is determined.

The main purpose of a Vertical Reference Frame is to serve as basis for the height determination of all kinds of other points in the landscape, on buildings etc.

Most often leveling methods are used for the measurements. The accuracy of precise leveling is rather high (1 cm of height difference error between two points 1 km apart), leading to problems in how to define a reference level (zero height) with the same accuracy.

The method used in Denmark, where access to coasts is plentiful, is to include tidal observation stations in the VRF. In these tidal stations, observations of the ocean tides have been carried out over a long period of time, making it possible to calculate a Mean See Level in each tidal station. The weighted "mean" of the mean see level in all the tidal stations is chosen as the Zero Level of the VRF.

It should be mentioned that the output of the leveling observations is Geopotential Differences rather than metric heights differences. In order to convert the observations into metric heights the gravity field of the earth must be known. For further information on the subject, refer to a textbook on Geodesy.

In the theory it is possible to include all stable points in the landscape in the height Frame and in this way to provide MSL-heights for each and every point. Vertically beneath each point we find a zero-level point. The collection of all the zero-level points is a zero level surface: the geoid. Ideally the geoid should be the equipotential surface in the gravity potential field of the earth, which coincides with the mean see level of the oceans. As it turns out, the used geoid has almost the same shape as that of the "ideal geoid" - the deviations are in the cm level.

In order to determine heights of points within the area covered by the VRF leveling methods can be used obtaining accuracies of a few mm's. As the GPS methods now are cheap and easy to use, everyone in the height business wants to use GPS measurements for determination of heights although the height determination is not as accurate as the leveling method. The cm level of accuracy is only able achieve through very long GPS observations (2010).
The GPS observations gives true 3D cartesic coordinates which may be converted to ellipsoidal grographical coordinates and ellipsoidal height. To convert the ellipsoidal height to the VRF height the shape, orientation and position of the reference geoid must be known within the 3D coordinate system used by the GPS satellites. Fortunately the same satellites make a determination of the geoid possible so the height of the geoid above/below the ellipsoid is known. The ellipsoidal height is by subtraction of the geoid height then transformed to VRF height.
The geoid being rather smooth can be represented via relatively few points in a regular grid. In Denmark some 400 points is forming the geoid grid. The geoid height is interpolated from the grid to the requested position.

The ellipsoid is chosen to have dimensions and positions close to those of the "ideal geoid" mentioned above. In this way the undulations of the geoids (our VRF zero level surface included) varies from -115 m to +65 m.
Before the age of GPS locally fitted ellipsoids were used giving smaller variations in the area of definition. Now we live in a global world using the GPS and a globally defined ellipsoid is convenient to use.

The Danish Vertical Reference Frame 1990: DVR90.

The relative heights of the stations in a Vertical Reference Frame do change over the years, caused by uneven land uplift/subsidence and by more local motions of the points. Also the Mean See Level will change over time.

The DVR90 is linked to the Mean See Level in 1990 as a weighted average of the mean sea level determined in 10 harbours on more than 50 years of Tide Gauge observations each place.
The geoid is named “dvr90g2002.01”.

In order to maintain a high accuracy of the VRF it is necessary to make new measurements, which of cause changes the heights. New methods for observations and calculations also affect the height values. Some stations get lost and new stations are included in the VRF. DVR90 was introduced to get a Vertical Reference Frame reflecting the ground truth about 1990.
The name of the old Frame is Danish Normal Zero (DNN) which actually covers more VRF names.

A table of Height Differences (new values minus old values) is included in KmsTrans. Via this table, the program can transform DNN heights into DVR90 heights and visa versa. The accuracy of this conversion is considered to be better than 2 mm. The old geoid DNN50g98.0 is not used any longer (see also *The Geoid*).

Transforming Ellipsoid Heights into VRF Heights:

The 3-Dimensional coordinates resulting from a GPS observation is converted to ellipsoidal coordinates - 3 coordinates, including a height above the ellipsoid.
This height is called the Ellipsoidal Height.

A list containing 3-D coordinates can be converted to a list of plane coordinates + VRF Heights via the *File to File Tranformation* in KmsTrans.

The program will automatically connect a Geoid Model for calculating Geoid Heights.

The standard geoid model for:

Denmark is dvr90g2002.01 giving DVR90 Heights. (accuracy ~1 cm)
The Faroe Islands is fvr09g2010.1 giving FVR09 Heights. (accuracy ~ 2 cm)
Greenland is gr2000g.06 giving Mean Sea Level Heights (MSL). (accuracy ~0.5 m)

The error in the determination of Mean See Level may exceed 20 cm as compared to similar determinations in other parts of the world. It is in year 2010 only possible to determine a common global MSL with accuracy in the 10 cm range.

Height Transformations

The label system includes the definition of heights systems (*Minilabels*).

Heights may then be transformed to other heights systems (legal in the area).

Se also: *Vertical Reference Frames.*

Example:

```
 #utm32Hetrf89_h_dvr90
1 001  6 240 996.785 m  479 340.836 m  20.000 m
1 002  6 128 456.592 m  522 749.196 m  21.0 m
1 003  6 130 868.167 m  595 096.463 m  22.0 m
1 004  6 154 180.064 m  693 971.061 m  23.0 m
-1 z
```

May be transformed to:

```
#geoHetrf89_h_dnn
1 001  56 18 47.77548 sx   8 39 57.76444 sx  20.088 m
1 002  55 18 07.18667 sx   8 21 29.98167 sx  21.122 m
1 003  55 18 54.01042 sx  10 29 54.36569 sx  22.081 m
1 004  55 29 42.58636 sx  12 04 14.60527 sx  23.079 m
-1 z
```

MiniLabels

The KMS Coordinate MiniLabels.

Was introduced to identify and read geodetic data (coordinates and observations). The concept of MiniLabels is used in the KMS Standard Format and in some other formats, when no description of coordinate system and datum may be found.

A MiniLabel is a short text string placed at the start of a data block, identifying the data in the block. A MiniLabel for a coordinate list tells the program which kind of coordinates is contained in the list (which coordinate system and datum).

When the concept of MiniLabels was extended to include height labels too the name may by a little misleading.

A data file can contain several data blocks, each block starting with a MiniLabel and terminated by a termination string first in a line. The termination string for coordinate blocks is "-1 z" and for observations "-1 a".

When used in data files the MiniLabel is headed by the character '#'. A program reading the file will look for this character and try to recognize the following text as a MiniLabel. If a MiniLabel is found the program decides whether the data block should be read or skipped and acts accordingly. Having reached the block termination the program normally starts another search for a minilabel via a lookout for character '#' and so on.
The search may be stopped by a STOP label: “#stop”.

Texts outside the data blocks will be skipped.

As no observation data are accepted by this transformation program, the following description will concentrate on Coordinate MiniLabels.

Coordinate MiniLabels comes in two kinds:

Coordinate MiniLabels Kind 1:

A string consisting of three components:
<coordinate system><separator><datum>[_<height minilabel>].

The *coordinate system* is mostly also readable for humans: the string "geo" indicates geographical coordinates, "utm33" represents UTM zone 33. In some of the other cases, the translation may not be quite obvious. Later in this topic you will find lists and examples further describing MiniLabel Components.

The *separator* is used in two ways:

1. Separate the coordinate system and the datum
2. Tell about the height system (and possibly the height mini label)

Note: that an extra separator char ‘_’ is placed before the *height minilabel*.
The *separator* consists of just one character having one of the values:

‘H’: Vertical Reference Frame: A height minilabel is requested after “datum”.
'E': Ellipsoidal Heights.
‘_’: No Heights.
'N': Normal Heights (i.e. the same as H and _h_msl).

The *datum* is the name of the datum (for coordinates) in small letters. For example:

`wgs84, etrf89, nad83g, qornoq`.

For some systems, the three components already described are not sufficient - extra parameters are needed. Such parameters (identifying for example the scale, a central meridian, translation of the coordinates etc) are placed after the "main" (3-Component) part of the MiniLabel. Having identified the "Main Part", the program knows how to read the extra parameters.

Below you will find lists and examples further describing MiniLabel Components.

A few kind 1 coordinate MiniLabels:

```
geo_wgs84     : Geographical Coord., Datum WGS84. No hights
utm32_etrf89  : UTM Zone 32, Datum ED50. No heights
crt_nad83g    : Cartesic Coordinates, Datum NAD83g. No heights
```

Coordinate MiniLabels Kind 2:

A string consisting of three components:

<coordinate system>[<separator>[_<height minilabel>]].

The second kind of minilabels is mostly used to identify "regional" coordinate systems. For this kind, the minilabel string consists of only a few letters, forming an (abbreviated) name of the system. Having identified a MiniLabel of this kind, the program knows the values of the implicit parameters needed for the transformation. These "implicit parameters" may include coefficients for transformation routine.

A few kind 2 coordinate Minilabels:

```
dktm1         : DK TM Zone 1 EUREF89 (E, N)
dktm2         : DK TM Zone 2 EUREF89 (E, N)
dktm3E        : DK TM Zone 3 EUREF89 (E, N) and ellipsoid height
dktm4         : DK TM Zone 4 EUREF89 (E, N)
kp2000j       : System 2000 Jylland
kp2000s       : System 2000 Sjælland
kp2000b       : System 2000 Bornholm
sbH_h_dvr90   : Great Belt and DVR90 heights
```

Height MiniLabels:

A string consisting of three components:

<height system>_<datum>.

The only legal separator is '_'.

A list of *height systems* and (height) *datum* is given below.

Prefixes indicating Region:

In order to avoid confusion when different stations in the same file are having the same station identification (station number), it has bees made possible to apply a "Region Prefix" to the

MiniLabel (and to the station identification as well). - this situation often occurs when stations from separate regions (countries) are mixed in the same file. When the MiniLabel for a coordinate block contains a "Region Prefix", this prefix applies to all stations in the block, except stations having their own region prefix in the ID.

Possible Region Prefixes:

PREFIX	REGION
DK	Denmark
FO	Faroe Islands
FE	Faroe Islands (Not used any longer)
GR	Greenland
SJ	Southern Jylland
IS	Iceland
NO	Norway
SF	Finland
SE	Sveden
SV	Sveden (Not used any longer)
BE	Belgium
CA	Canada
DE	Germany
EE	Estonia
FR	France
LE	Latvia
LT	Lithuania
LI	Lithuania
NL	Netherlands
PL	Poland
UK	England
US	USA

Example of a coordinate minilabel with region prefix: `DK_utm33_etrf89`

List of Coordinate Systems:

The List contains a listing of the sub strings used in the MiniLabels to indicate Coordinate System.

In the collum marked 'Suppl Params' you will find which extra parameters are needed to define the system. Coordinate Systems marked "P.D." has predefined datum; - such systems are fully defined via the name of the coordinate system and therefore neither datum nor extra parameters are needed in the label.

Other elements contained in the "Suppl param" column indicate which extra parameters are needed for definition of the system. In the KmsTrans program, such parameters can not be selected directly via the boxes or buttons. Systems needing extra parameters can in the program be defined via the reading of a full label (including the parameters) from a file. (se after Datum).

The extra parameters are in a file written right after the 'normal' label, using double spaces and/or NL's as separators.

Reading of a MiniLabel from a 'Label File' is selected from the System Drop down lists:
Select the item 'Label from File' at the bottom of the list.

The character '*' found in some of the coordinate system names in the list below are place holders for ciphers.
For example, in the UTM systems, they indicate where to put the zone number. In the Conical Systems used in Greenland, the zones are called cones (numbered from 1 to 8) and the '*' character tells where to put the 'cone number'

MiniName	Suppl Param	Description
Global Systems		
crt		Cartesian 3-d coord
geo		Geographical coord (Lat, Lon)
geoi		Geographical coord (Lon, Lat)
utm**		UTM zone ** (** = 2 digits) (N,E)
utmi**		UTM zone ** (** = 2 digits) (E,N)
utm**n		UTM zone **, North. LAT (N,E)
utmi**n		UTM zone **, North. LAT (E,N)
utm**s		UTM zone **, South. LAT (S,E)
utmi**s		UTM zone **, South. LAT (E,S)
itm	B0 N0 Lc Ec Scale	TM, general GAUSS-KR (N, E)
itmi	B0 N0 Lc Ec Scale	TM, general GAUSS-KR (E, N)
tm**		GAUSS-KR ** dg 3dg.z scale 1.0
mrc	B0 N0 Lc Ec	Mercator projection
mrc0		Mercator Std Projection
lmb	B0 N0 Lc Ec Bc	Lambert conf. con.
dlmb	B0 N0 Lc Ec B1 B2	Lambert 2 par. c. con.
elmb	B0 N0 Lc Ec B1 B2	Lambert eql. c. con.
npstg		North polar stereographic
spstg		South polar stereographic
upsn		Universal polar stereogr N
upss		Universal polar stereogr S
stg	Bc Nc Lc Ec scale	Stereogr. projection
estg	Bc Nc Lc Ec B1 B2	Eql. Stereogr. projection
bnstg	B1 scale	NP. Stereogr. scale at B1
bsstg	B1 scale	SP. Stereogr. scale at B1
safle		Sansom-Flamsteed eq.pr., ell.
safl		Sansom-Flamsteed equiv. proj.
lmbac		Lambert equiv. cyl. proj.
lmbap		Lambert equiv. pol. proj. (N)
lmbaps		Lambert equiv. pol. proj. (S)
auth		Authalic geogr. Crd.
Region Europe		
etrs-tm**	P.D.	etrs89 tm zone **
ETRS-TM**	P.D.	etrs89 tm zone **
etrs-lcc**	P.D.	etrs89 Lambert conf. con
ETRS-LCC**	P.D.	etrs89 Lambert conf. con
etrs-laea	P.D.	etrs89 Lmb Azimuthal Equal Area
ETRS-LAEA	P.D.	etrs89 Lmb Azimuthal Equal Area
Region Denmark		
dktm1	P.D.	DK TM1 etrf89 (E, N)
dktm2	P.D.	DK TM2 etrf89 (E, N)
dktm3	P.D.	DK TM3 etrf89 (E, N)
dktm4	P.D.	DK TM4 etrf89 (E, N)
kfmr	P.D.	Kbh Frb Metroring, etrf89
kp2000j	P.D.	System 2000 Jylland, etrf89
kp2000s	P.D.	System 2000 Sjælland, etrf89

kp2000b	P.D.	System 2000 Bornholm, etrf89
dmrc	P.D.	Dansk Merkator etrf89
s34j	P.D.	System 1934 Jylland
s34s	P.D.	System 1934 Sjælland
s45b	P.D.	System 1945 Bornholm
s34b	P.D.	System 1945 Bornholm
dm	P.D.	Dansk Merkator ed50
gsgeo	P.D.	geogr. crd, gs
gsbgeo	P.D.	geogr. crd, gsb
gs	P.D.	GS conf. con. DK
gsb	P.D.	GS conf. con. Bornholm
kk	P.D.	Kbh. komm. system
os	P.D.	Ostenfeldt system
asb	P.D.	Øresund bridge proj.
Dks	P.D.	Øresund bridge proj, special
Sb	P.D.	SB bridge proj.
Sbf	P.D.	SB bridge proj., inverted
Region Faroe Islands		
Fke	P.D.	Conf. con. FO, euref89
fg50	P.D.	FO geogr. crd, ed50
fu50	P.D.	utm zone 29, top_ed50
fg54	P.D.	FO geogr. crd, fd54
fk54	P.D.	Conf. con. FO, fd 54
fk89	P.D.	Conf. con. FO, fd 54a
Region Greenland		
gk*w	P.D.	conf. con, W-GR, qornoq
gk*e	P.D.	conf. con, E-GR, qornoq
Region Estonia		
eel2p	P.D.	Estonian Lambert, 2 std par.
eetm**	P.D.	Estonian Gauss-Kr **, 3dg.z
eetm*	P.D.	Estonian Gauss-Kr *, 3dg.z
eebm	P.D.	Estonian Basic Map
eegeo	P.D.	geogr. crd, Pulkovo 1942
eecrt	P.D.	Cartesic crd, Pulkovo 1942
eelmne	P.D.	Estonian Lmb 2 par., epv37
eelmse	P.D.	Estonian Lmb 2 par., epv37
Region Sweden		
rt38g	P.D.	RT38g, 2.5 gon vest
rt90g		RT90g, 2.5 gon vest
rt90v	P.D.	RT90v, spec. for dks
rt38v	P.D.	RT38v, spec. for dks
Region IceLand		
lmbhjo	P.D.	Lambert Conf. Con Hjørsey
islmb	P.D.	Lambert Conf. Con wgs84 IS

Where in the *Suppl Param* Collum:

P.D.	Predefined Datum
B0, Bc	Latitude Constant
Nc	Northing Constant
L0, Lc	Longitude Constant
Ec	Easting Constant
Scale	Scale (close to 1 usually)
B1, B2	Latitude parallels for definition of scale.

List of Separators:

The Separator in a Coordinate MiniLabel tells which kind of Height Information is included in the list:

H	Height described in height minilabel
E	Ellipsoid Heights
_	No Heights
N	Normal Heights: short for: H … _h_msl

This separator is written in the MiniLabel right after the coordinate system sub string. It acts as:

1. 'real' separators between the sub strings indicating coordinate system and datum respectively.
2. Information on presence of height system.

(See *Vertical Reference Frames*).

For the systems having a Predefined datum (P.D.), the datum should not be explicitly written in the label, here the separator is placed as an appendix to the coordinate system sub string.

Accordingly, a MiniLabel indicating the following list to contain dhtm1 coordinates - and DVR90 heights will look like:

```
#dktm1H_h_dvr90
```

List of Datum:

The following list contains the datum supported by the KMS Transformation System (and by KmsTrans)

Parent Datum indicates the structure in the datum-hierarchy used internally by the transformation system.

The character '@' at the start of some descriptions marks that this datum is only used in connection with one of the projection systems having a predefined datum.

Coordinate Datum	**Description**	**Parent datu**	**Ellipsoid**
wgs84	World Geodetic System 1984	ed50	WGS84
etrf89	EUREF 89	wgs84	GRS80
etrs89	EUREF 89	wgs84	GRS80
euref89	EUREF 89	wgs84	GRS80
gr96	Greenland Ref. Frame 1996	wgs84	GRS80
ed50	European Datum 1950	ed50	Hayford
nad83g	North Ame. D.1983 Greenland	nwl9d	GRS80
qornoq	Qornok Datum 1927 (til WGS84)	nwl9d	Hayford
scosd	Scoresbysund datum	nwl9d	Hayford
ammlk	Ammassalik datum	nwl9d	Hayford
s34j	@ System 1934 Jylland	ed50	Hayford
s34s	@ System 1934 Sjælland	ed50	Hayford
s45b	@ System 1945 Bornholm	ed50	Hayford
gs	@ Generalst. Sys., Jyl. + Sjl	ed50	GS
gsb	@ Generalst. System, Bornholm	ed50	GS
os	@ Ostenfeldt System	ed50	Bessel

kk	@ Københavns Komm. System	ed50	Dansk
sb	@ Storebælts System	ed50	Hayford
sbi	@ Storebælts System inv.	ed50	Hayford
dks	@ DKS	ed50	Hayford
asb	@ ASB	ed50	Hayford
fd54	Færø Datum 1954	ed50	Hayford
fg54	@ Geogr. FD 1954	etrf89	Hayford
fg50	@ Færø, Geogr. ED 1950	etrf89	Hayford
fk54	@ Konf. con. FD 1954	etrf89	Hayford
fu50	@ UTM 29, Topogr. grid, ED 50	etrf89	Hayford
fk89	@ Konf. con. FD 1989	etrf89	Hayford
	(NOT ETRF89)		
srt90g	SRT90, Sverige	wgs84	Bessel
rt90g	RT90, Sverige	wgs84	Bessel
rt90v	@ RT90v	ed50	Bessel
rt38v	@ RT38v	ed50	Bessel
rt38g	@ RT38g	ed50	Bessel
ed87	European Datum 1987	ed50	Hayford
wgs72	World Geodetic system 1972	nwl9d	WGS72
nad83	North American Datum 1983	wgs84	GRS80
nad27	North American D.1927, Conus	wgs84	Clarke66
nad27c	North American D.1927, Canada	wgs84	Clarke66
pu42	Pulkowo 1942, temporary	wgs84	Krassovsky
island	Hjørsey datum 1955	wgs84	Hayford
nwl9d	Naval Weapons Laboratory	wgs84	NWL9D
ed79	European Datum 1979	wgs84	Hayford
dhdn	Deutsches Hauptdreiecksnetz	ed50	Bessel
dhdnd	Deutsches Hauptdreiecksnetz	ed50	Bessel
dhdn1	Deutsches Hauptdrnetz, DOEDOC	etrf89	Bessel
dhdn2	Deutsches Hauptdrn, DOEDOC5p	ed50	Bessel
dhdn3	Deutsches Hauptdrn, DOEDOC7p	ed50	Bessel
eesti42	@ EESTI 1942	etrf89	Krassovsky
ain1970	@ Ain El Abd 1970	wgs84	Hayford
nahrwan	@ Nahrwan 1967	wgs84	Clarke80
qng24	@ Qatar Nat. Grid System 1924	wgs84	Hayford
qbc2001	@ Qatar Bahrain Causeway	wgs84	WGS84
qnd1995	@ Qatar National Datum 1995	wgs84	Hayford

Vertical Datum	**Description**	**Ellipsoid**
dvr90	@ Danish Vertical Ref Frame 1990	GRS80
evrf2000	@ Eropean Vertical Ref Frame 2000	GRS80
fvr09	@ Faroe Vertical Ref Frame 2009	GRS80
msl	@ Mean Sea Level Frame	GRS80
dnn	@ DNN: gm91/gi44/h_msl	Hayford
gm91	@ Gradmålingen 1891 height	GS
gi44	@ G.I. 1944 Height system	Hayford
kn44	@ Kbh. Nul 1944 kotesys.	Hayford
ee1940	@ ESTONIA 1940 Vertical Frame	Krassovsky
ee1948	@ ESTONIA 1948 Vertical Frame	Krassovsky
ee1977	@ ESTONIA 1977 Vertical Frame	Krassovsky
qnhd	@ Qatar National Height Datum	Hayford

As an example of a system demanding supplementing parameters we can use the ITM system. This system is (like the UTM) a transversal mercator system. In the ITM, you can via the extra parameters select the scale, central meridian and offsets for the coordinates.

For the ITM System the suppl. parameters (and the order they should appear) is found in the coordinate system list:

```
B0 N0 Lc Ec Scale
```

The content of an ITM Label File could be:

```
#itmHetrf89_h_dvr90  0 sx  0 m  9 00 00 sx  500000.0 m  0.9996
```

or using other units:

```
#itmHetrf89_h_dvr90  0 dg  0 m  9 dg  500 km  0.9996
```

This ITM label is actually the UTM zone 32 label:

```
#utm32Hetrf89_h_dvr90
```

More Examples of MiniLabels:

```
geo_etrf89:
Geographical Coordinates, Datum etrf89, No Heights.

geoEetrf89:
Geographical Coordinates, Datum etrf89. Ellipsoidal Heights

utm32_euref89 :
UTM coordinates  zone 32, Datum etrf89. No Heights.

dktm1E:
Dansk TM zone 1, Ellipsoidal Heights.

dktm2:
Dansk TM zone 1, No Heights. The '_' character may be omitted in
the 'P.D.' systems.

crt_euref89:
Cartesic Coordinates, Datum Euref89.
In Cartesic Systems the Height Component of the minilabel is just
the '_' character as no Heights are accepted.
```

Units for Distances, Angles and Coordinates

Coordinate Terminations indicating Unit Types

In the KMS Standard Format for coordinates, each coordinate value is terminated by one or two characters indicating which units are used. When a non-terminated coordinate is read, default units are used. The dialog boxes for coordinate transformations have Radio Buttons for selection of the default units for geographical coordinates.

These Unit Radio Boxes determine which default units should be use for geographical coordinates.

A unit-termination of a coordinate will always override the default unit selection.

These unit terminations are also used to angles and distances.

The unit types come in two groups. The first is used for angles and geographical coordinates, the second for distancess and metric (non-geographical) coordinates.

Group 1: Angles and Geographical Coordinates :

```
dg:     Degree Units: 360 degrees, decimal dg.
nt:     Nautic Units: 360 degrees, 60 decimal minutes.
sx:     Sexadecimal Units: 360 degrees, 60 min., 60 decimal arc
seconds.
rad:    Radians
gr:     Centidecimal Units: 400-degrees, decimal gr.
cc:     Centidecimal Units: 400-degrees, 100 minutes, 100 decimal
seconds.
```

The ‘gr’ and ‘cc’ units are not used for coordinates (or seldom).

Group 2: Distances and Metric (Non-Geographical) Coordinates

```
km:     Kilometers
m:      meters
mm:     millimeters
cm:     centimeters
```

For metric coordinates, the default unit is meter (m).
For geographical coordinates, the default unit is arc seconds (sx).

Single space / double space:
In the KMS Standard System, a single space character inside a coordinate string is ignored. Such single space chars are used for making the coordinates more readable for humans. Normally a coordinate and its unit termination are separated by a "blind" space char (it looks nicer that way). Any double space will terminate the coordinate string which when not intended will lead to incorrect reading of the coordinate string.

Examples :

geogr coordinates :

```
60 00 34.3 sx       (Ok)
60  0 34.3 sx       (Error: minutes must have two digits)
0 00 34.3 sx        (Ok: leading zeros can be omitted)
0 34.3 sx           (ok: leading zeros can be omitted)
```

```
1203344.555sx       (ok)
44 55.6 nt          (ok)
1 23 56.777         (no unit termination: default unit used)
```

metric coordinates:

```
6 555 666.77 m      (ok)
5678.456 km         (ok)
55  33.44 m         (double space terminates the string)
```