4T2 Analyser
Coverage Analysis step-by-step Guide

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Introduction

Advanced Broadcast Components Ltd. 4T2 RF-Analyser and 4T2 Content Analyser applications provide second-to-none measurement capabilities for digital broadcasting.

Instruments manufactured by Advanced Broadcast Components Ltd. in various configurations benefit from these two software packages.

The following document describes the use of RF-Analyser and Content-Analyser in terrestrial applications for mobile coverage (drive-by) measurements using DVB-T or DVB-T2 transmissions.

The aim of such measurements is to verify the coverage area of existing terrestrial transmission. The data derived shall help in refining the coverage prediction models.
Multiple measurement-runs allow to document the influence of different climate conditions (summer/winter), or man made factors (vehicle reflections/noise) to the reception quality.

Integrated drive-by testing of up to 4 RF-channels (option to support up to 8 RF-channels on request) is currently available from Advanced Broadcast Components Ltd. in the 4T2 Portable the 4T2 Rack and the 4T2 broadcast multi probe.

Both instruments contain up to 4 DVB-T/T2 capable receivers. Their measurement results together with position information from the global positioning system (GPS) can be automatically logged to file for subsequent analysis. Furthermore, the results are visualised on the go by superimposing selected values on a map of the area. Export filters are available to enter the coverage data into Google Earth, or Google Maps.

The receiver hardware itself is using tuner/demodulator combinations also found in commercial set-top-boxes, making the measurement results comparable to what the client receiver hardware will be able to decode, or not.

In order to perform drive-by measurements, some preparation is required. The scope of this document is to explain the steps and give some additional information along the way.

1 Drive-by preparations

For drive-by measurements, there are 3 pre-requisites required:

a) To superimpose measurement results on a map, you will need a map that you can load into the RF-Analyser application.

b) To measure field-strength, you will need a calibrated antenna with known antenna factor. This factor will be needed to be entered into the RF-Analyser application.

c) You will need a GPS receiver attached to the instrument (generally any GPS receiver following the NMEA- protocol on a physical or virtual serial com port and supporting the records RMC, CGA, VTG will work). Typically, the GPS receiver is part of the package.

How drive-by measurements are performed and how the application is meant to be operated, is the scope of this document. Should any description herein be unclear, or misleading, we strongly encourage you to provide feedback.
Please send any comments to info@4T2.eu. Your feedback can only make this document better.

2 Getting Map Data, ABC MapMaker application

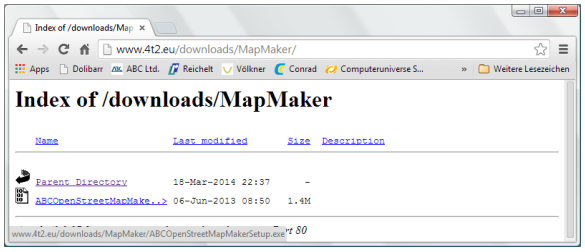
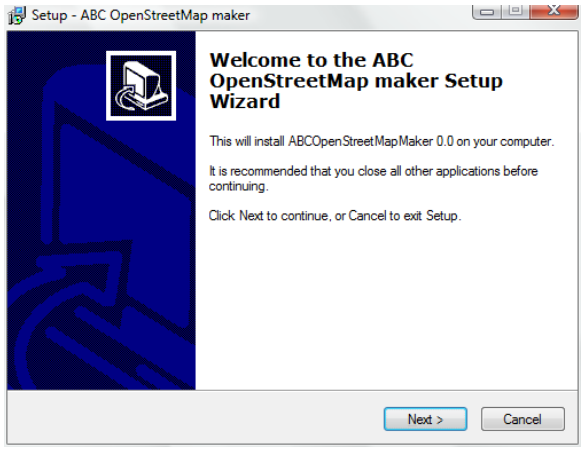
The **ABC MapMaker** application is a windows program to retrieve map-data from internet servers, such as **Open Street Map**, or **GoogleMaps**.

Automated geo-referencing allows for direct import into **4T2™ RF-Analyser** application to visualise the transmitter coverage area.

The software loads map-tiles of a mouse-selectable region in an automated process and combines them into a single map file.
To allow a smooth import into the 4T2 RF-Analyser, the map file name contains the coordinates (longitude and latitude information of the upper left and lower right corners) of the map graphical file.

2.1 Installing ABC MapMaker on your system

The software can be downloaded from the ABC servers and installed on any computer (or virtual machine) running Windows operating system.

1		This is the URL of the MapMaker application on ABC's web-server
2		Feel free to install the application on as many computers as you like.
3		ABC is not related with the OpenStreetMap project. We ask you to accept their terms and conditions of use, if you want to use their map data.

OpenStreetMap project is open source and supported by a large community, volunteering to improve the database. We ask you to agree with their terms and conditions. No data is sent anywhere during this process.

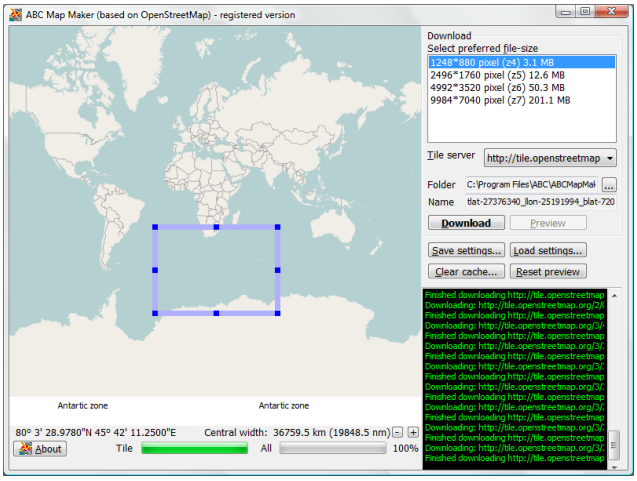
The **ABC MapMaker** application only provides a means of loading data off the internet that is already there and provided by the **OpenStreetMap** project.
ABC does not own the map data that is downloaded by the **ABC MapMaker** application, nor is ABC in any way involved in the generation of those map source files.

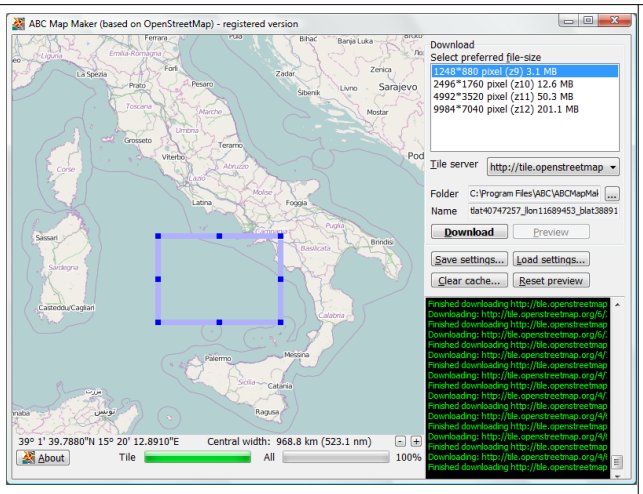
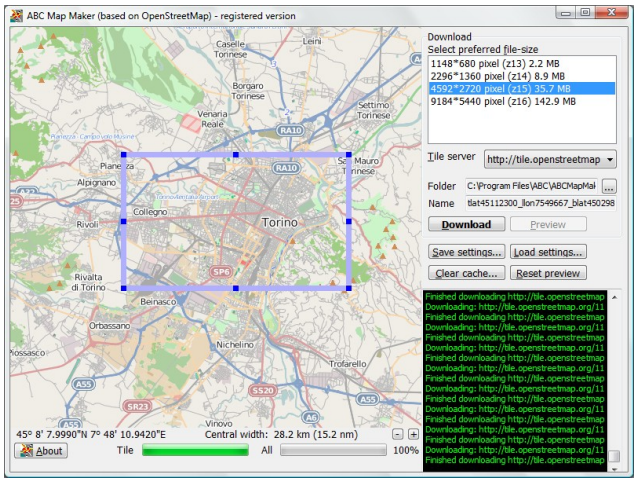
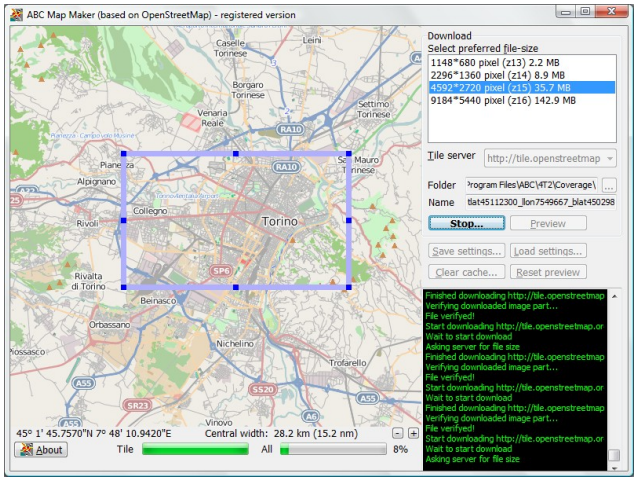
What the **ABC MapMaker** application does, is providing a user interface for easy selection of the area to download, easy overview and selection of the resolution to download and, most importantly, to retrieve the map data organised in tiles from the server and to combine all together in a single file.

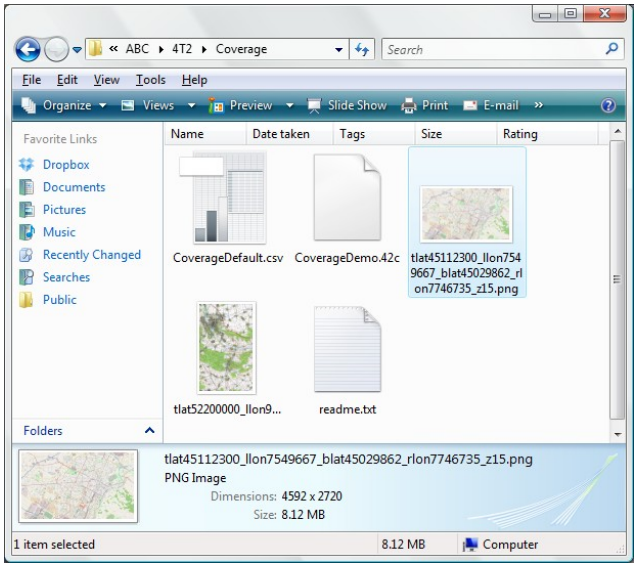
There is a free registration process available for the **ABC MapMaker** application. The registration allows to combine tiles to larger maps. To register, please follow the instructions given by the application.

Note(s):
On Windows Vista and newer, please run the program with administrator privileges
ABC MapMaker requires an active internet connection to perform the download.
Loaded tiles are cached on the internal storage, making subsequent downloads potentially faster.
Free registration allows to load higher resolution files.

2.2 Running ABC MapMaker and storing map data

1		Start the application for the first time and you will find the world to select from. Say, you would like to do a job in Italy, we try to find it on the map by zooming into the area. Zoom is performed by opening a rectangle with the mouse from the upper left corner to the lower right corner and holding down the mouse button while doing so. Alternatively, you will find '+' and '-' buttons in the lower right area, or you can use the buttons on the keyboard.

2		Many zoom-ins later, we find Italy. If you zoomed-in too far, you can use the reverse motion to zoom back to one zoom level above. If you are positioning the mouse pointer towards the edges of the displayed map, the pointer changes to a hand symbol. If you click then, the map will be shifted 25% in the corresponding direction. The upper right area of the screen shows the available tile resolution and the resulting file-size of the downloaded pixel file. The actual file loaded will contain information framed by the blue rectangle. The blue rectangle can be re-sized and positioned by the mouse.
3		The original Italian Job movie was about a robbery taking place in the streets of Turin, so this is where we go and load the data. Note that the rectangle is adjusted for the area we want to load and the file size is highlighted for the second highest resolution. The application allows you to specify the target folder of the downloaded files. We do recommend to set this to 'c:\Program Files\4T2\Coverage\' By doing so, the map files will be stored in the RF-Analyser project folder for coverage drive-by measurements.
4		After clicking 'download', the application loads the tiles off the internet, stores them all on disk and when done, combines the tiles to a single file with longitude and latitude information in the file name.

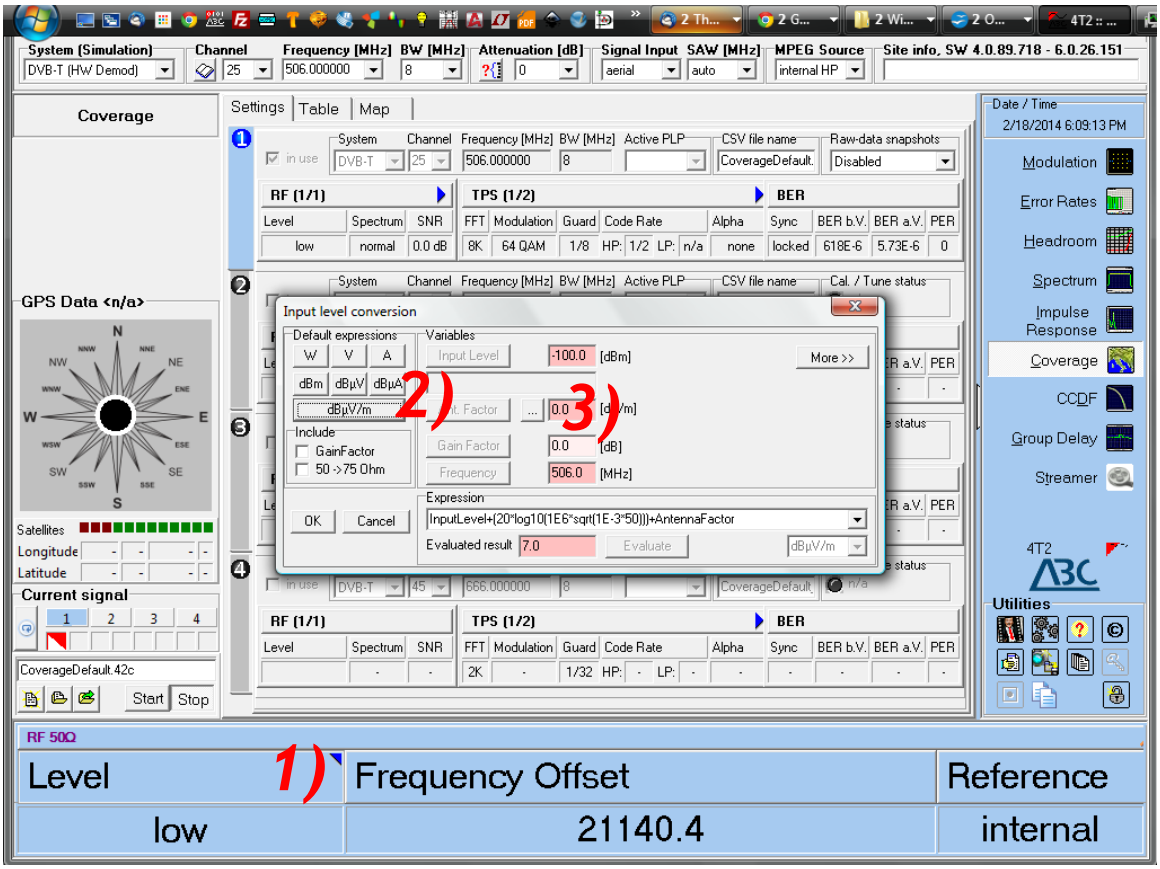
5		Here is the map-file in the right folder with the coordinates as the file-name. Please note the readme.txt file, containing the latest information about the folder and file structure used in the coverage analysis function. The file contains the reference position in the file name as described above. The ABC MapMaker application stores files in .png format. The 4T2 RF-Analyser software accepts map-files in many pixelated formats (png, jpg, bmp,..)

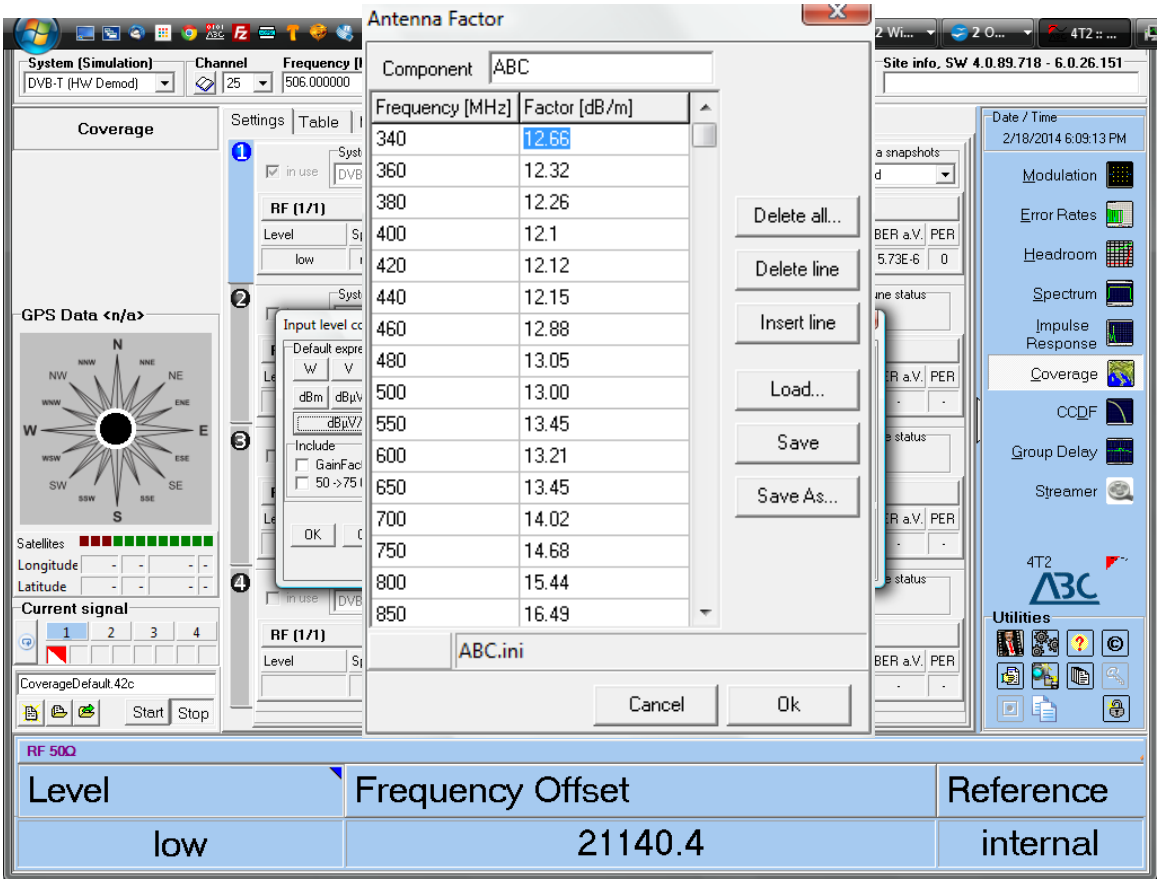
3 Entering Antenna-Factor(s) into RF-Analyser

In order to display **field-strength**, the **RF-Analyser** application requires to know the antenna conversion factor of the measurement antenna used.
A table with these frequency dependant factors is generally part of the delivery of the measurement antennas.

4 steps need to be followed to make the RF-Analyser display the right field-strength.

1) Click on Level to open "Input level conversion" dialogue
2) click on "dBuV/m" (field-strength unit)
3) Click on "..." to open Antenna factor entry
4) Optional Gain Factor entry allows for level offsets





Antenna Factors can be entered as a pair of Frequency and Factor.
Should the required channel not be in the list provided by the antenna manufacturer, then the application will interpolate to the best possible match.

All data can be saved to and retrieved from a file. A component designator can be stored with the file.

The Antenna factor files can be copied from one instrument to another, should the component be required to be used with this other instrument.

Below is an extract of antenna factor data provided by the company Schwarzbeck for their RE4590-model. The last column is the one to be entered into the table as antenna-factor.

RE 4590 VHF- UHF Rundempfangsantenne
RE 4590 VHF-UHF Omnidirectional Antenna

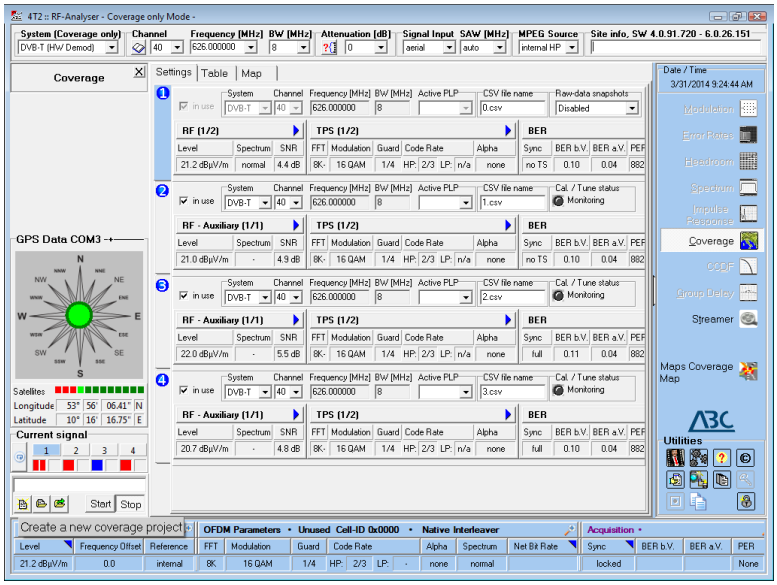
Frequency Frequenz	Wavelength Wellen-länge	Gain(Isotr.) Isotrop-gewinn	Gain(Dipole) Gewinn über Dipol	Ant.-Factor Ant.-Wand-lungsmaß
MHz	m	dBi	dBd	dB/m
350.00	0.86	-5.67	-7.82	26.77
355.00	0.85	-5.88	-8.03	27.11
360.00	0.83	-5.41	-7.56	26.75
365.00	0.82	-4.82	-6.98	26.29
370.00	0.81	-4.39	-6.54	25.98
375.00	0.80	-4.12	-6.27	25.82
380.00	0.79	-4.05	-6.20	25.87
385.00	0.78	-3.89	-6.04	25.82
390.00	0.77	-3.98	-6.13	26.02
395.00	0.76	-3.77	-5.92	25.92
400.00	0.75	-3.20	-5.35	25.46

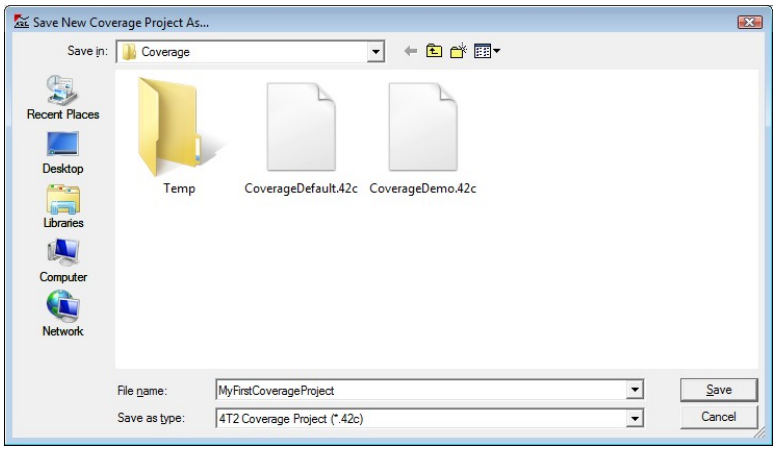
4 4T2 RF-Analyser / Coverage

The **Coverage Analysis** function of the **4T2 RF-Analyser** allows the simultaneous logging of key performance parameters of up to 4 receiver modules together with position data derived from a GPS receiver. These combined data is stored to disk.

The coverage file format is comma separated values and can be converted to any file format for post-processing, e.g. using coverage prediction or spreadsheet software.

1



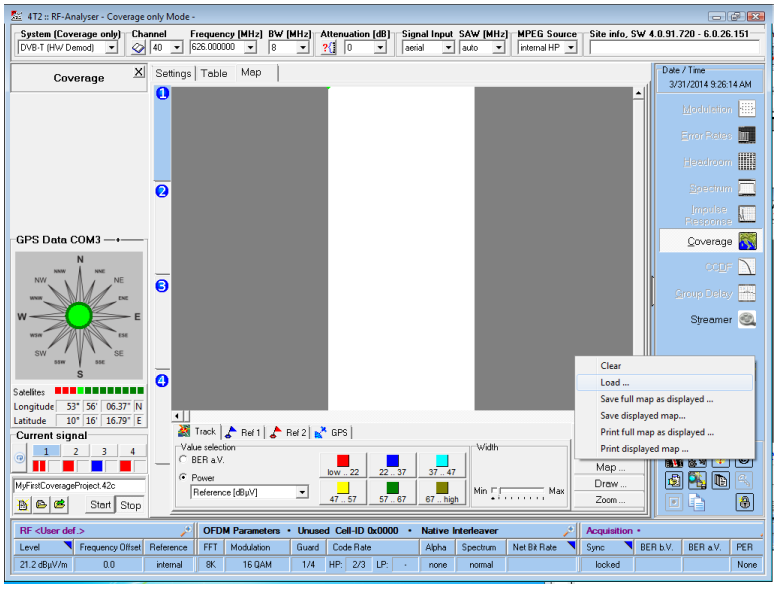
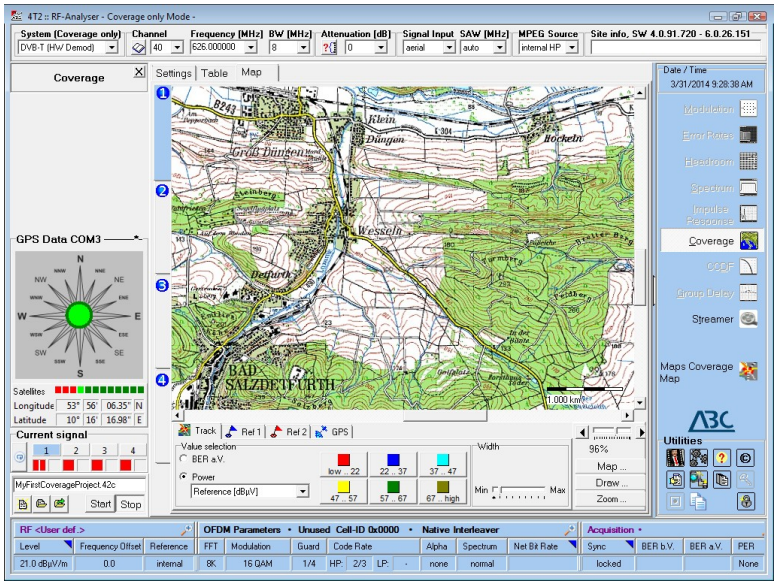
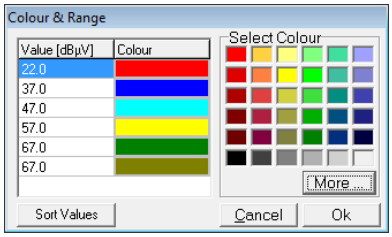


To perform **Coverage Analysis** the first step is to start a new **CoverageProject**.

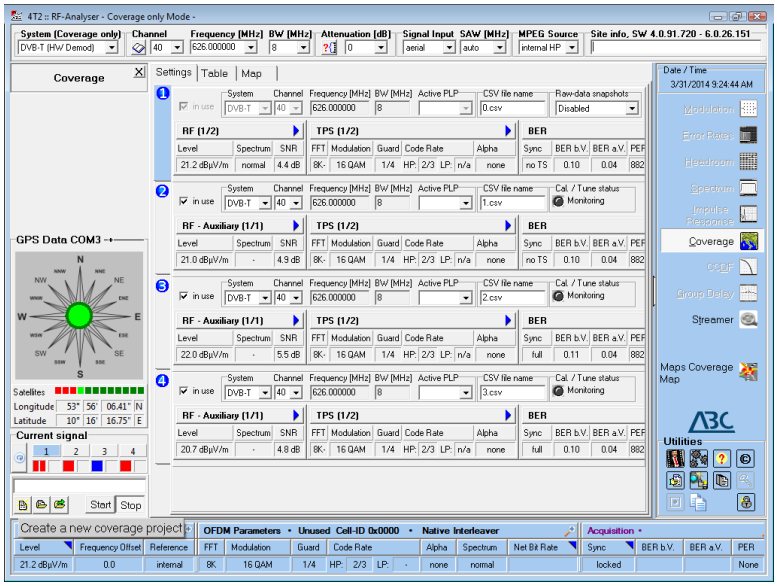
Press the icon-button in the lower left corner to define a project file-name and folder-location.

The project file format is a zip-file, containing project information and the csv-files containing the measurement results for each receiver activated.

The file extension is .42c indicating a 4T2 coverage project.

2		After you have confirmed the new project file, the name is indicated in the field above the icon-buttons. In order to load a map to the project, click on Map/load and specify a map file-name. Should the map-file be generated by the MapMaker application, you can use the reference data for the automatic scaling of the map. (Scaling is required because this process relates the pixel-format map-file to the GPS coordinates).
3	 	Once the map is loaded, measurement values can be plotted on the map when the measurement is started. The **settings-tab** configures the receivers. The **Table-tab** shown the measurement results as they are logged in the csv-files. The **Map-tab** visualises the measurement results on the map. In the latter two tabs, the selector 1..4 selects which receiver module data is actually displayed. The track-subtab allows for the selection of visualisation properties (like which colour corresponds to which fieldstrength). The **Colour & Range** dialogue is opened by clicking any of the 6 threshold indicator buttons.

4



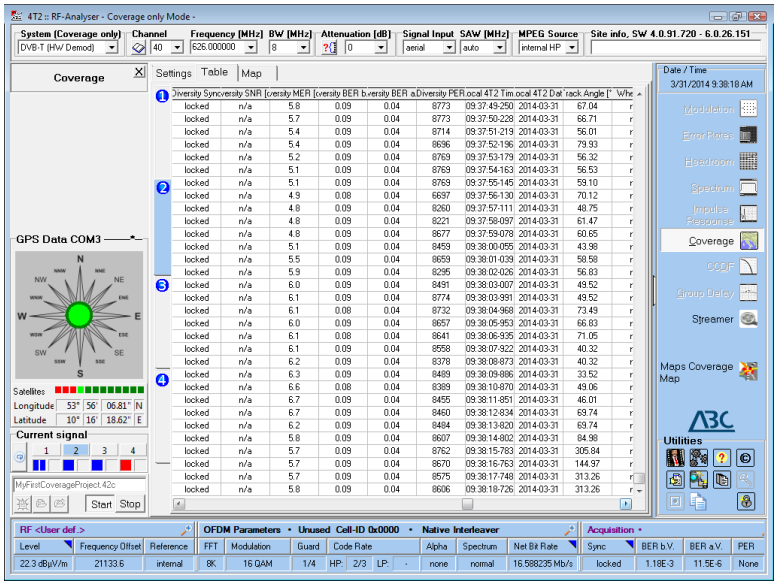
The settings-tab configures the receivers.

Here you can select the transmission format (DVB-T/T2) and the input channel.

In case of DVB-T2, the PLP to demodulate can be selected (or auto for the first available PLP).

Please note that the receiver on the first position is controlled by the settings in the uppermost line.

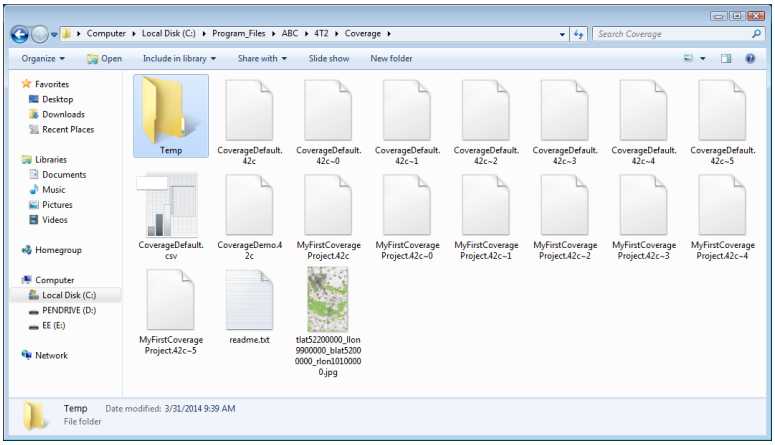
5



By pressing **Start**, the measurement run starts.

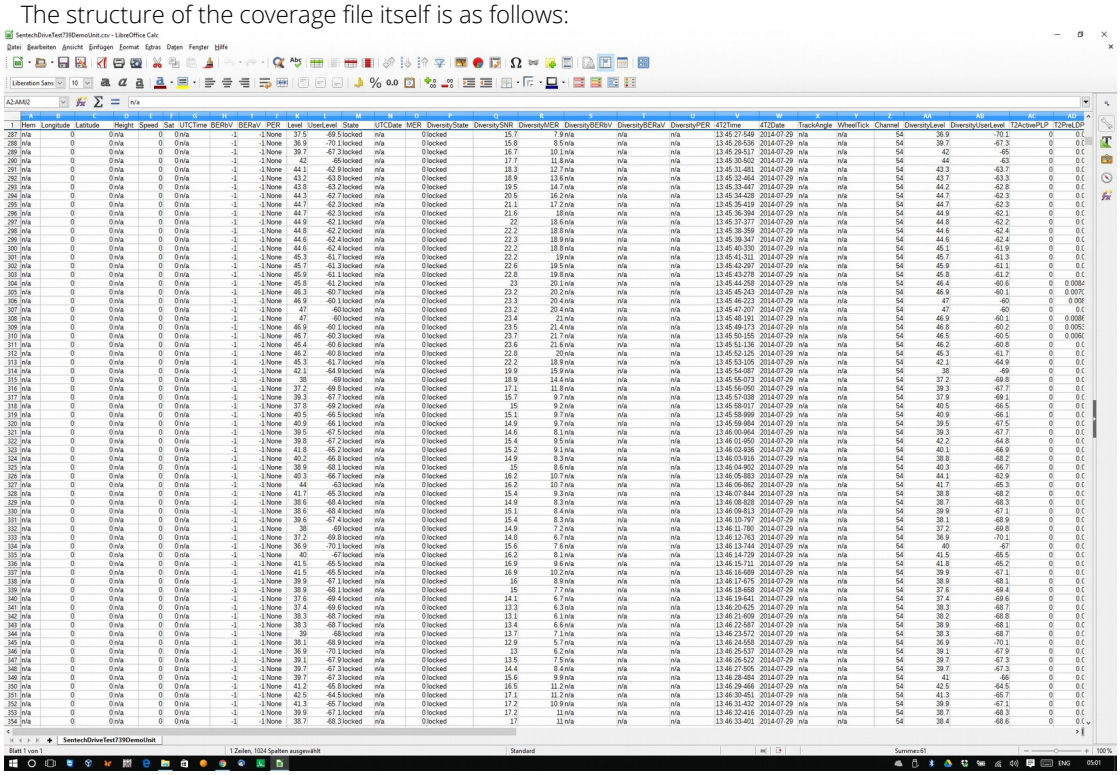
You can check the logging of the individual receivers by selecting the **Table-tab**, and by highlighting the receiver module.
(Please note that it takes about 10 seconds after pressing start until the logging begins. This time is required for the tuning/calibration process)

6

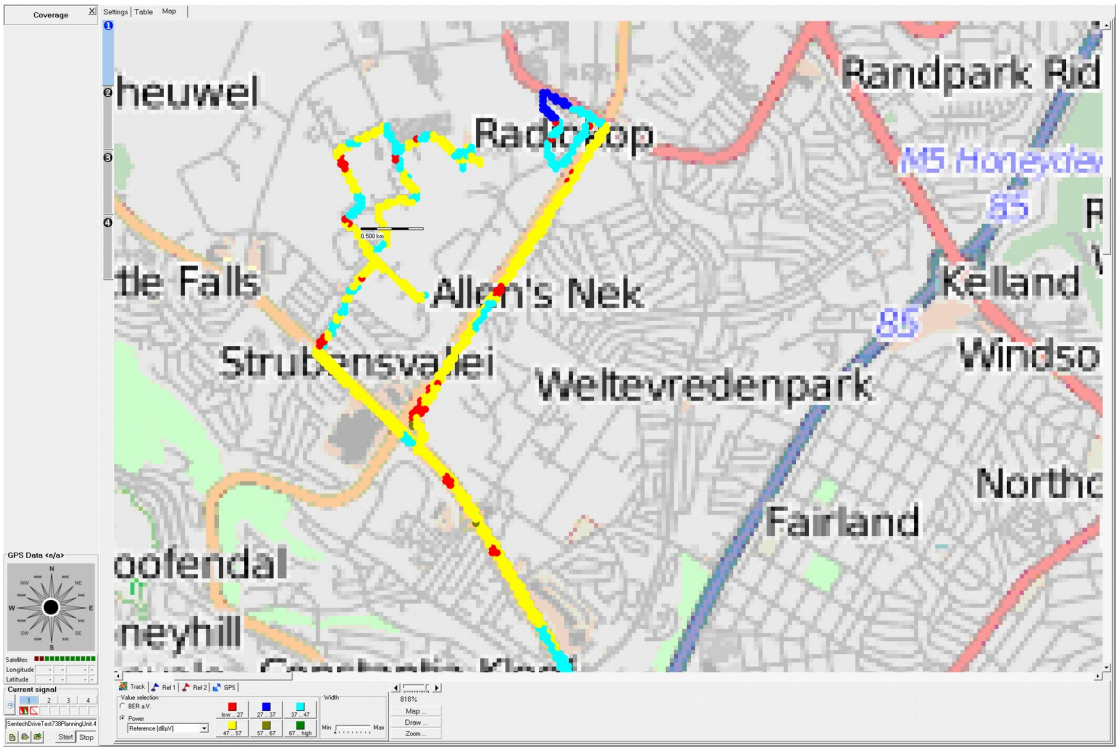


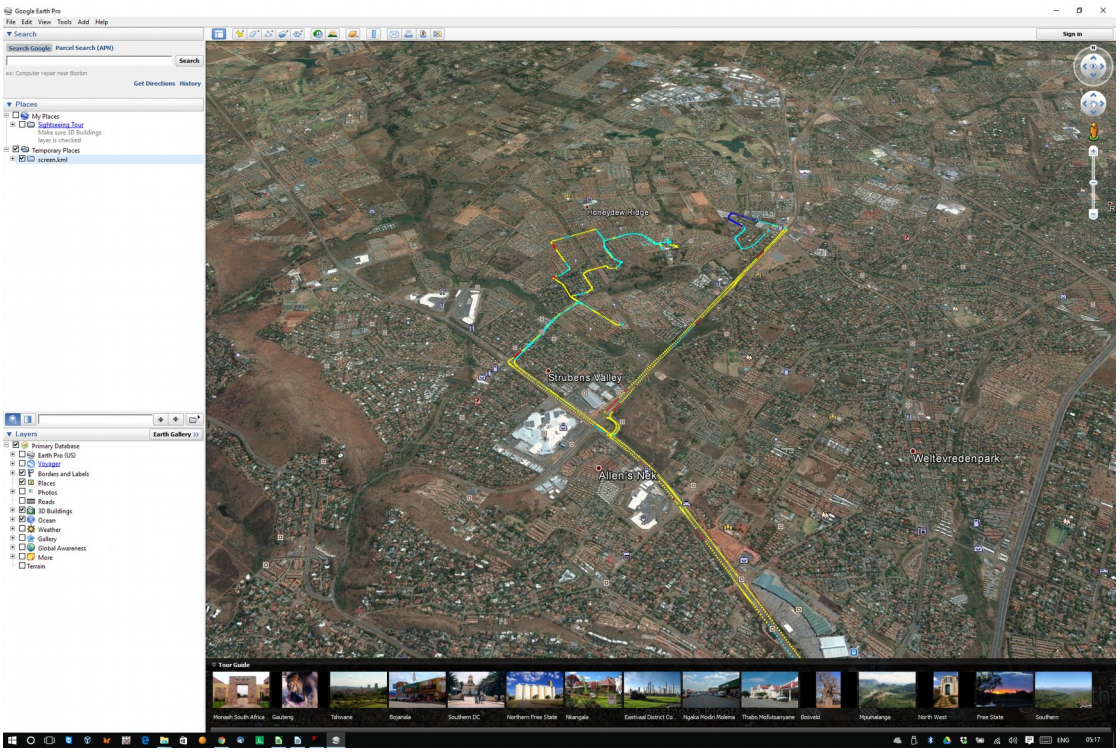
For post processing of the logged measurement data, it is required to get access to the .csv files.

It is recommended to copy the .42c file to a different location and change the extension to .zip.
Double click in Windows explorer shows the contents of the .42c file.

	Please note that there 4T2 RF-Analyser automatically generates up to 10 backup copies of the coverage project files. The backup copies carry the extensions .42c~0 to .42c~9. A backup is generated every time you press start to start the measurement logging. The temp folder contains the working files during the coverage measurements. When you press start, the application unzips the coverage project file into this folder. During the measurement run, the files are appended there. When you close the application or generate a new coverage project, the files are zipped back again into the coverage project file, where the original files get renamed cyclically to generate backups. The temp folder is emptied after successful completion of this process. Should there have been a problem (program crash, disk full), there are still files in this folder. On starting the RF-Analyser application again, it will detect this anomaly and ask you what to do with the files. The structure of the coverage file itself is as follows:  Any spreadsheet application can be used to open the comma separated value files generated by the Coverage Analyser. There is one file generated per receiver installed in the system. Some data, like the GPS information is identical in each of the files to assure that the data for evaluation is consistent per channel or PLP measured.
7	Documentation capabilities have been simplified through an output interface to Google maps or GooglePro systems. The 4T2 RF-Analyser exports kml and kmz files of coverage project files. All visual settings, such as colours corresponding to field-strength are converted for use with highest quality geo-renderers. In addition to preserving visual settings, the driving vector is indicated, thus allowing for directional antenna estimates.

A comparison between the map display during the actual drive-by test and the exported kml displayed in Google Maps is shown here:





There are options available to either export all track data, or just the selection visible on the 4T2 Coverage analyser display.

The export function is called-up through the menu opening on clicking the map-button.

8 File Structure on Disk

The Coverage Analyser stores Project File(s) to disk. The structure is as follows:

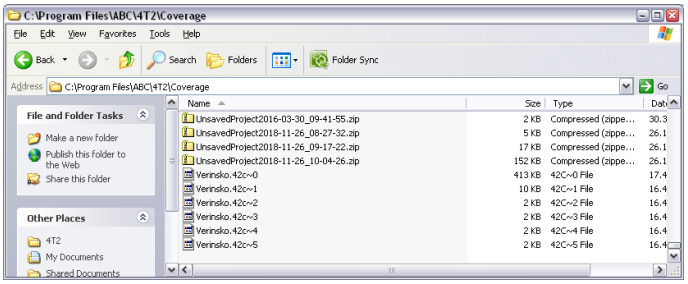
On creating a new Coverage Project:

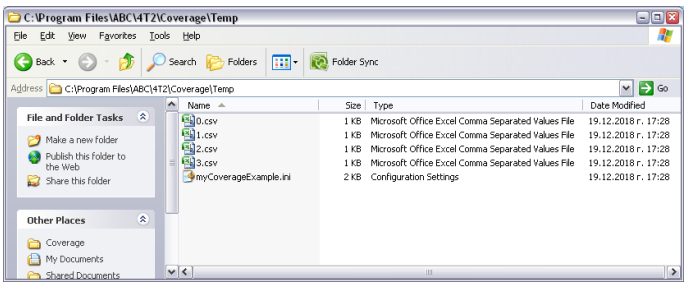
Example: myCoverageProjectOne
Files on Disk: myCoverageProjectOne.42c
in \Coverage\Temp\
myCoverageProjectOne.ini
0.csv
1.csv
2.csv
3.csv

On closing the 4T2 RF-Analyser application:

File myCoverageProjectOne.42c is copied to myCoverageProjectOne.42c~0
Files in \Coverage\Temp\ are zipped back into myCoverageProjectOne.42c and then deleted

If something went wrong:
Files in \Coverage\Temp\ are zipped into UnsavedProjectYYYY-MM-DD_hh-mm-ss.zip
The \Coverage\Temp\ directory will not be emptied





On Opening the 4T2 RF-Analyser application:

4T2 RF-Analyser checks if there are files in \Coverage\Temp\
if yes, then user action is required
if no, the applications opens the last coverage project, in our case here:
myCoverageProjectOne.42c

5 Miscellaneous

The 4T2 can be used to superimpose measurement results on a map of the coverage area, but it is not mandatory to do so. This means that one can perform coverage measurements without loading a map file.
We do, however, encourage you to use the map display feature as this is some kind of an online verification during the measurement session.

To use a map for the coverage analysis you will need to have a map-file of sufficient size and resolution in a bitmap format (PNG, JPEG, and BMP supported).
After setting two reference pins, the map is scaled (this is done automatically when loading the file with ABC MapMaker). It is not mandatory to set the reference pins before starting the measurement session. They can be altered during a running measurement session, if necessary.

The tracks can be stored to bitmap file with or without the underlying map. Prints can be done the same way to create overhead slides or paper printouts. The printing dialogues can be found on the lower right side of the screen, when the map tab-sheet is active.

To show the video content of the demodulated data of the receivers, you can use the 4T2 Content-Analyser application. Please note to check the 'TS only' checkbox in the tuning dialogue of the corresponding receiver module. This allows 4T2 RF-Analyser to have exclusive control of the tuning process and to have exclusive access to the measurement data, while the 4T2 Content-Analyser performs all transport stream related measurements without both applications interfering with each other.