

Convert NMEA 0183 to waypoint files for R&S®SMU200A Application Note

Products:

- | R&S®SMU200A
- | R&S®SMU-K44
- | R&S®SMU-K65

This application note describes how to convert GPS routes from NMEA 0183 file format to waypoint files that can be used by the R&S®SMU200A Vector Signal Generator.

Table of Contents

2	Overview	3
3	File formats	4
4	Program GPS Route Converter	5
5	Interpolation of Waypoints.....	6
6	Troubleshooting	7
6.1	File access errors	7
6.2	Functional errors	7
7	Literature	9
8	Additional Information.....	9
9	Ordering Information	9

2 Overview

The R&S®SMU 200A Vector Signal Generator is capable of generating GPS satellite signals. As it is part of the A-GPS test scenarios for 3GPP FDD and GSM (Performance Test Scenario#3), the option R&S®SMU-K65 Assisted GPS enhances the option R&S®SMU-K44 GPS by user-definable moving scenarios, which can also be used for testing stand-alone GPS-receivers. The user has the possibility to define a movement by means of a so-called “waypoint” file, which will lead to a “moving” of the connected GPS-receiver. To simulate a movement route with GPS satellite signals the R&S®SMU 200A Vector Signal Generator needs a waypoint file in a specific file format.

GPS Devices can create a file saving the route they are taken. However, these files are usually stored in a format called NMEA 0183 (Figure 1). This format cannot be read by the Rohde & Schwarz R&S®SMU200A directly but has to be converted into the waypoint file format. This can be done using the tool GPS Route Converter, which comes with this Application Note.

The following abbreviations are used in this Application Note for Rohde & Schwarz test equipment:

The R&S®SMU200A Vector Signal Generator is referred to as SMU.

The option R&S®SMU-K44 Digital Standard GPS is referred to as SMU-K44.

The option R&S®SMU-K65 Assisted GPS is referred to as SMU-K65.

3 File formats

The following pictures show the NMEA 0183 file format and the waypoint file format used by SMU.

```

$GPRMC,060001,A,3348.795,N,11754.064,W,0.0,0.0,0.0,110698,013.7,E*62
$GPRMB,A,,,,,,,,,V*71
$GPGGA,060001,3348.795,N,11754.064,W,1.07,1.0,65.8,M,-31.9,M,,*4F
$GPGSA,A,3,14,15,16,18,22,25,29,,,,,2.2,1.0,1.9*38
$GPGSV,2,1,07,14,70,322,55,15,31,212,53,16,32,317,54,18,10,282,47*7C
$GPGSV,2,2,07,22,40,120,53,25,36,045,52,29,28,073,50,,,,*4B
$PGRME,19.5,M,44.7,M,48.8,M*10
$GPGLL,3348.794,N,11754.064,W,060002,A*3E
$PGRMZ,217,f,3*1F
$PGRMM,WGS 84*06
$GPBOD,,T,,M,,*47
$GPRTE,1,1,c,0*07
$GPRMC,060003,A,3348.794,N,11754.064,W,0.0,0.0,0.0,110698,013.7,E*61
$GPRMB,A,,,,,,,,,V*71
$GPGGA,060003,3348.794,N,11754.064,W,1.07,1.0,66.2,M,-31.9,M,,*45
$GPGSA,A,3,14,15,16,18,22,25,29,,,,,2.2,1.0,1.9*38
$GPGSV,2,1,07,14,70,322,56,15,31,212,53,16,32,317,54,18,10,282,47*7F
$GPGSV,2,2,07,22,40,120,52,25,36,045,52,29,28,073,50,,,,*4A
$PGRME,19.5,M,44.7,M,48.8,M*10
$GPGLL,3348.794,N,11754.064,W,060004,A*38
$PGRMZ,217,f,3*1F
$PGRMM,WGS 84*06
$GPBOD,,T,,M,,*47
$GPRTE,1,1,c,0*07
$GPRMC,060005,A,3348.794,N,11754.064,W,0.0,0.0,0.0,110698,013.7,E*67
$GPRMB,A,,,,,,,,,V*71
$GPGGA,060005,3348.794,N,11754.064,W,1.07,1.0,66.4,M,-31.9,M,,*45
$GPGSA,A,3,14,15,16,18,22,25,29,,,,,2.2,1.0,1.9*38
$GPGSV,2,1,07,14,70,322,56,15,31,212,53,16,32,317,54,18,10,282,47*7F
$GPGSV,2,2,07,22,40,120,53,25,36,045,52,29,28,073,50,,,,*4B
$PGRME,19.5,M,44.7,M,48.8,M*10
$GPGLL,3348.793,N,11754.064,W,060006,A*3D
$PGRMZ,218,f,3*10
$PGRMM,WGS 84*06
$GPBOD,,T,,M,,*47
$GPRTE,1,1,c,0*07

```

Figure 1: NMEA 0183 file

The GPS Route Converter picks the Global Positioning System Fix Data lines (starting with \$GPGGA) and converts them into the waypoint file format (Figure 2).

```

RESOLUTION: 2000
-117.901067,33.813233,66.200000
-117.901067,33.813233,66.400000
-117.901067,33.813217,66.700000
-117.901067,33.813200,66.900000
-117.901067,33.813217,67.000000
-117.901050,33.813250,66.800000
-117.901050,33.813250,66.600000
-117.901033,33.813250,66.600000
-117.901033,33.813233,66.500000
-117.901033,33.813233,67.100000
-117.901033,33.813217,67.300000
-117.901033,33.813217,67.200000
-117.901033,33.813200,67.600000
-117.901033,33.813200,68.000000
-117.901033,33.813183,68.400000
-117.901033,33.813217,68.600000
-117.901033,33.813217,68.800000
-117.901017,33.813217,69.200000
-117.901017,33.813217,69.400000
-117.901017,33.813200,69.900000
-117.901017,33.813183,69.900000
-117.901017,33.813183,70.600000
-117.901017,33.813167,70.900000
-117.901017,33.813167,71.500000
-117.901033,33.813167,72.100000
-117.901033,33.813150,72.600000
-117.901033,33.813150,72.900000
-117.901017,33.813183,73.500000
-117.901017,33.813200,73.900000
-117.901050,33.813200,75.300000
-117.901050,33.813217,75.800000
-117.901050,33.813200,76.500000
-117.901050,33.813183,77.700000
-117.901050,33.813183,78.400000
-117.901050,33.813167,79.400000

```

Figure 2: Waypoint file

4 Program GPS Route Converter

The GPS Route Converter tool only consists of the file GPS_Route_Converter.exe and doesn't need to be installed. Simply copy GPS_Route_Converter.exe to a convenient location on your computer and double_click this file to start the program.

When running the GPS Route Converter the main program window is presented showing five Buttons (Figure 3).

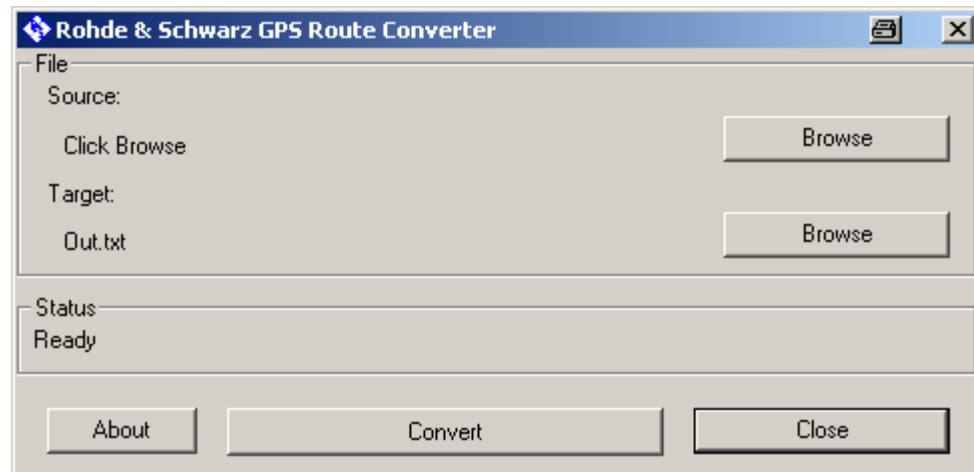


Figure 3: Main window

Clicking onto the button labeled "About" will bring up a second window showing product version as well as legal information.

The button labeled "Close" will close the GPS Route Converter.

To convert a file using the GPS Route Converter, execute the following steps:

Load a source file

Click the upper Browse button to open a File Open Dialog which you can use to select a source file. This must be a valid NMEA 0183 file. If it is not valid, the Status Line will show "Error: incorrect file type".

If the loading sequence succeeds, the Status Line will show "Sourcefile defined".

Define a target file name

This step is optional. If it isn't taken, the program will create or overwrite a file named Out.txt in the same directory as the source file.

If you want to define a target file, click the lower Browse button. This will open a File Save Dialog allowing to define a target file name. If the file already exists you have to confirm to overwrite it. The Status Line will show "Targetfile defined".

This file will not be created or changed until you click the Convert button, so if you accidentally chose the wrong file you can still change it without destroying existing files.

Convert the file

To start the conversion, click the button labeled Convert.

The Status Line changes to "Converting...", showing that the conversion sequence is running.

If for some reason the source file cannot be opened, the conversion process will fail showing the Status Line "Error opening source file, aborted". The Status Line "Error opening target file, aborted" may occur for the target file failing to be opened or written to. For more information, see Troubleshooting.

If no error occurs or all errors could be compensated by the program, the Status Line will show "Conversion successful" after finishing.

Transfer the file to the SMU

Use an USB Stick or a LAN connection to transfer the waypoint file to the SMU. Refer to the SMU Operating Manual for further information.

5 Interpolation of Waypoints

In order to generate a smooth GPS receiver movement, the SMU needs waypoints in equidistant time steps.

While recording NMEA files, sometimes the GPS receiver omits some positions. This may happen if the GPS receiver moves below road bridges, tunnels or large trees.

In order to avoid rapid movements of the SMU GPS simulation, GPS Route Converter analyses the NMEA file and makes a linear interpolation in case of missing location information.

6 Troubleshooting

Errors can be divided into two categories: File access errors, which can be discovered by the program and Functional errors, which lead to malfunction of the program without notice.

6.1 File access errors

File access errors will be indicated by error messages in the Status Line. The following messages might appear:

Error opening file

Returned by the file opening sequence, indicating that the filename is invalid or the file is not accessible.

Error: incorrect file type

Returned by the file opening sequence, indicating that the file isn't a valid NMEA 0183 file or that it doesn't contain any of the GPS data needed for the conversion process.

Error opening source file, aborted

Returned by the conversion sequence, indicating that the file is not accessible. The most common reason is that no source file has been defined. If a source file has been loaded, then it must have been changed by another application or user between the loading sequence and the conversion.

Error opening target file, aborted

Returned by the conversion sequence, indicating that the filename is invalid or the file is not accessible. Unlike the loading of a source file, the definition of the target file does not check for any errors, so if there is an error related to the target file, it won't show up until the conversion is started.

The most common reason for this error is that the target file is read-only.

6.2 Functional errors

The program is designed to compensate random time fluctuation as well as a large number of possible errors in the source file to remain compatible to the wide range of GPS devices and possible inconsistency supported by the NMEA 0183 format. However in some extreme cases the compensation and completion algorithm could lead to unexpected behaviour. This will not be detected by the program, but there are some hints that can be spotted by the user.

Long conversion time

The duration of the conversion sequence primarily depends on the size of the source file and the speed of the Computer running GPS Route Converter. On a modern Computer, even a source file containing multiple hours of GPS waypoints at an average time interval should be converted within a few seconds. If the conversion takes unusually long you should consider the steps described below.

Large output file

The output format is much more compact than the NMEA 0183 format, so the output file should be considerably smaller. If not, there might be two reasons.

1. In the source file, there is one or more huge time gaps. The output format uses a static time step, so the program must fill those gaps with intermediate steps. This is normal behavior and is not considered to be an error.
2. Due to an unfavorable structure in the source file, the program chooses an unnecessary small time step size thus making the file bigger. The output file will not contain any wrong data, but it will be larger and the loading process in the SMU will take longer.

A good estimation for an upper limit of the file size would be about half the size of the source file.

What to do

If you think, one of these errors might have happened to your conversion, you have some diagnostic options.

Starting the GPS Route Converter with the parameter `"/debug"` will generate a file named `Debug.txt` in the same directory as the output file. This file contains some information about the conversion process, for example the number of steps generated between two specific values from the source file.

Starting the program with the parameter `"/timestep=[value]"`, while `[value]` is a integer that stands for a time in milliseconds, will force the output file to have the defined time between two steps rather than the one calculated by the program. This can be used to correct the error where the time step is too small.

To find out what time step has been used, open the output file or the file `Debug.txt` in a text editor. It is the value in the first line, after `"RESOLUTION: "`.

7 Literature

- [1] [R&S@SMU200A Operating Manual](#)
- [2] [GPS / A-GPS - Digital Standard for R&S@Signal Generators Software Manual](#)
- [3] <http://www.gpsinformation.org/dale/nmea.htm>

8 Additional Information

Please send any comments or suggestions about this Application Note to TM-Applications@rohde-schwarz.com.

For additional information about signal generators visit the Rohde & Schwarz website at www.rohde-schwarz.com.

9 Ordering Information

For additional information about these instruments, see the Rohde & Schwarz website www.rohde-schwarz.com or contact your local representative.

Signal generator and options, ordering information		
Type of instrument	Designation and range	Order No.
R&S@SMU200A	Vector Signal Generator	1141.2005.02
R&S@SMU-B10	RF path A 100 kHz to 2.2 GHz	1141.8503.02
R&S@SMU-B11 (2 Options required)	Baseband Generator with ARB (16 Msample) and Digital Modulation (realtime)	1159.8411.02
R&S@SMU-B13	Baseband Main Module	1141.8003.04
R&S@SMU-K44 (2 Options required)	GPS	1161.0566.02
R&S@SMU-K65	Assisted GPS	1415.0053.02

Note: Only the minimum requirements are listed above. The use of R&S@SMJ and R&S@SMATE Vector Generators is also possible.
Please contact your local Rohde & Schwarz sales office for further assistance.

About Rohde & Schwarz

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