

R&S[®]SMBVB-K363, R&S[®]SMW-K363

Chinese Car Navigation Test Suite User Manual



1179767902
Version 01

ROHDE & SCHWARZ
Make ideas real



This manual describes the following R&S®CMWrun option for software version V1.9.12 or higher:

- R&S®SMBVB-K363 (Chinese car navigation test suite)
- R&S®SMW-K363 (Chinese car navigation test suite)

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The following abbreviations are used throughout this manual: Options R&S®SMBVB-K363 and R&S®SMW-K363 are abbreviated as R&S SMx-K363. R&S® is abbreviated as R&S.

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1 Key features

The test suites R&S SMx-K363 provide Chinese car navigation tests with the sequencer tool R&S CMWrun. The tests are performed on a connected in-vehicle system (IVS). The tests are as closely aligned with the Chinese test specifications "Technical specification for on board satellite positioning system" as possible.

The test equipment simulates a global navigation satellite system (GNSS). The R&S CMWrun controls the test equipment via SCPI commands and the IVS typically via vendor-specific commands. The test cases can be performed fully automatic, without user interaction.

Table 1-1: Supported test cases

Test case	Chapter of "Technical specification for on board satellite positioning system" and test purpose
1. Output	6.3.1: Functional test if dedicated NMEA messages can be outputted by DUT. See also annex C.1.1 and annex C.2 - table C.2 of the specification.
2. Supporting satellite signal consistency	6.3.2: Functional test if GSV sentences output the received satellite information of the expected systems and GSA gives the satellites with better signal. See also annex C.1.1 and annex C.2 - table C.2 of the specification.
3. Independent BeiDou static positioning accuracy open sky	6.3.3.1.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1, annex C.2 - table C.3, and annex D.2 of the specification.
4. Static positioning accuracy open sky	6.4.1.1.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1, annex C.2 - table C.1, and annex D.2 of the specification.
5. Independent BeiDou static positioning accuracy urban canyon	6.3.3.1.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.2, annex C.2 - table C.3, and annex D.2 of the specification.
6. Static positioning accuracy urban canyon	6.4.1.1.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.2, annex C.2 - table C.1, and annex D.2 of the specification.
7. Independent BeiDou dynamic positioning accuracy open sky	6.3.3.2.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1, annex C.2 - table C.4, and annex D.2 of the specification.
8. Dynamic positioning accuracy open sky	6.4.1.2.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1, annex C.2 - table C.2, and annex D.2 of the specification.
9. Independent BeiDou dynamic positioning accuracy urban canyon	6.3.3.2.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.2, annex C.2 - table C.4, and annex D.2 of the specification.
10. Dynamic positioning accuracy urban canyon	6.4.1.2.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.2, annex C.2 - table C.2, and annex D.2 of the specification.
11. Independent BeiDou velocity accuracy open sky	6.3.3.3.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1, annex C.2 - table C.4, and annex E.2 of the specification.
12. Velocity accuracy open sky	6.4.1.3.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1, annex C.2 - table C.2, and annex E.2 of the specification.
13. Independent BeiDou velocity accuracy urban canyon	6.3.3.3.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.2, annex C.2 - table C.4, and annex E.2 of the specification.

Test case	Chapter of "Technical specification for on board satellite positioning system" and test purpose
14. Velocity accuracy urban canyon	6.4.1.3.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.2, annex C.2 - table C.2, and annex E.2 of the specification.
15. Independent BeiDou cold start time to first fix	6.3.3.4.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.3 of the specification.
16. Cold start time to first fix	6.4.2.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.1 of the specification
17. Independent BeiDou hot start time to first fix	6.3.3.4.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.3 of the specification.
18. Hot start time to first fix	6.4.2.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.1 of the specification
19. Independent BeiDou reacquisition time	6.3.3.5: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.3 of the specification.
20. Reacquisition time	6.4.3: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.1 of the specification
21. Independent BeiDou acquisition sensitivity	6.3.3.6.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.3 of the specification.
22. Acquisition sensitivity	6.4.4.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.1 of the specification
23. Independent BeiDou reacquisition sensitivity	6.3.3.6.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.3 of the specification.
24. Reacquisition sensitivity	6.4.4.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.1 of the specification
25. Independent BeiDou tracking sensitivity	6.3.3.6.3: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.3 of the specification.
26. Tracking sensitivity	6.4.4.3: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1 and annex C.2 - table C.1 of the specification
27. Independent BeiDou timing performance open sky	6.3.3.7.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1, annex C.2 - table C.3, and annex F.2 of the specification.
28. Timing performance open sky	6.4.5.1: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.1, annex C.2 - table C.1, and annex F.2 of the specification.
29. Independent BeiDou timing performance urban canyon	6.3.3.7.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.2, annex C.2 - table C.3, and annex F.2 of the specification.
30. Timing performance urban canyon	6.4.5.2: Functional test if the outputted positioning accuracy by DUT fulfills the requirements. See also annex C.1.2, annex C.2 - table C.1, and annex F.2 of the specification.

2 Prerequisites

- R&S CMWrun base software, version 1.9.12 or higher.
No smart card and no licenses are required for R&S CMWrun.

Required equipment for **R&S SMBVB-K363**:

- R&S SMBV100B for GNSS simulation must be equipped with the following options:

Hardware:

- HW option R&S SMBVB-B103

Minimum required options:

- R&S SMBVB-K520 real-time extension
- R&S SMBVB-K107, BeiDou
- R&S SMBVB-K106, SBAS

Additional options for full test coverage:

- R&S SMBVB-K44, GPS
- R&S SMBVB-K66, Galileo
- R&S SMBVB-K94, GLONASS
- R&S SMBVB-K108, antenna pattern, spinning and attitude simulation for test location accuracy with moving receiver, blockage, and environment model

Required equipment for **R&S SMW-K363**:

- R&S SMW200A for GNSS simulation must be equipped with the following options:

Hardware:

- HW option R&S SMW-B10
- HW option R&S SMW-B13
- HW option R&S SMW-B103/-B203

Minimum required options:

- R&S SMW-K107, BeiDou
- R&S SMW-K106, SBAS

Additional options for full test coverage:

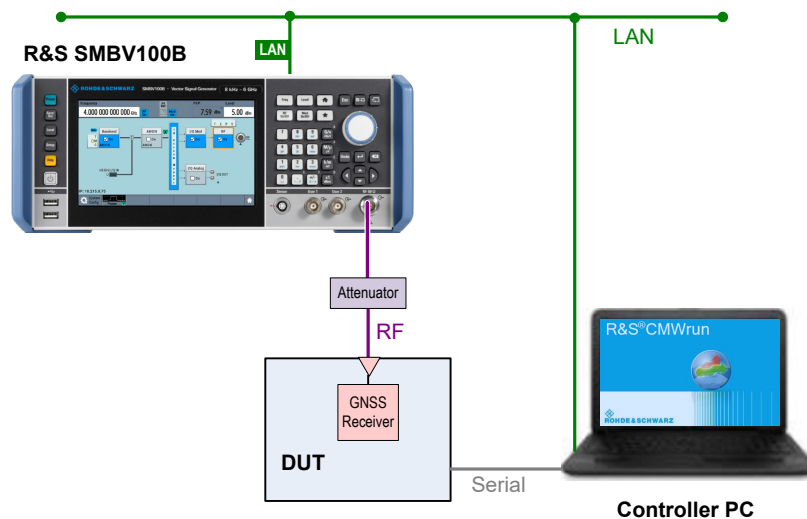
- R&S SMW-K44, GPS
- R&S SMW-K66, Galileo
- R&S SMW-K94, GLONASS
- R&S SMW-K108, antenna pattern, spinning and attitude simulation for test location accuracy with moving receiver, blockage, and environment model

Oscilloscope for optional PPS accuracy testing (tests 27 to 30)

- Supported oscilloscopes:
 - R&S RTM3002 (1335.8794K02)
 - R&S RTM3004 (1335.8794K04)

3 Test setup

The following figure provides an overview of the test setup. In this example, the instrument R&S SMBV100B is used. The test setup with another supported instrument is similar.



The test setup comprises the following components:

- An instrument providing GNSS signals to the DUT for positioning. Connect the RF output port of the instrument to the RF port of the DUT (GNSS receiver).
- A computer executing the R&S CMWrun. The computer controls the instrument via SCPI connections (typically LAN). It controls the DUT typically via vendor-specific commands on a serial port interface.
- External attenuator is recommended for levels below -120 dBm, refer to "[External Power Attenuation](#)" on page 20.

Test setup with an oscilloscope

If you optionally use an oscilloscope to test the PPS accuracy, also connect the output of your DUT to a channel input of the oscilloscope.

4 System configuration

This chapter describes everything that you have to do before using the system for the first time. Skip this chapter if you already have an operable system.

- [Preparation of controller PC](#)..... 9
- [Preparation of instrument connection](#)..... 9
- [Preparation of DUT connection](#)..... 10

4.1 Preparation of controller PC

To set up the controller PC, install the base software of R&S CMWrun. No smart card and no licenses are required for the R&S CMWrun with the R&S SMx-K363 Chinese navigation test suite.

Refer to the sequencer user manual, section Installation.



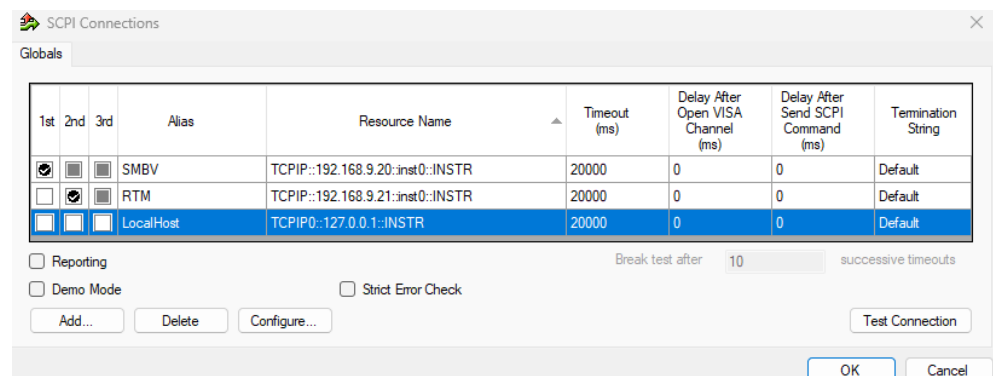
Ignore the message indicating no license is found.

4.2 Preparation of instrument connection

1. For remote control of the instrument, configure the resource settings "Resources" > "SCPI Connections". Configure the SCPI resource settings compatible to the instrument.

For the control of R&S SMBV100B, use the entry with an alias "SMBV". For the control of R&S SMW200A, use the entry with an alias SMW.

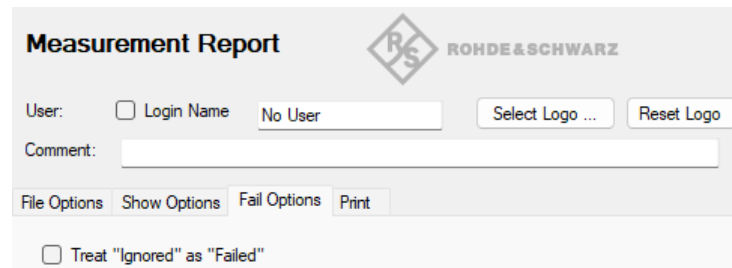
For optional testing with an oscilloscope, use the entry with an alias "RTM".



Refer to the sequencer user manual, section Resources > SCPI Connections.

2. Configure measurement report settings.

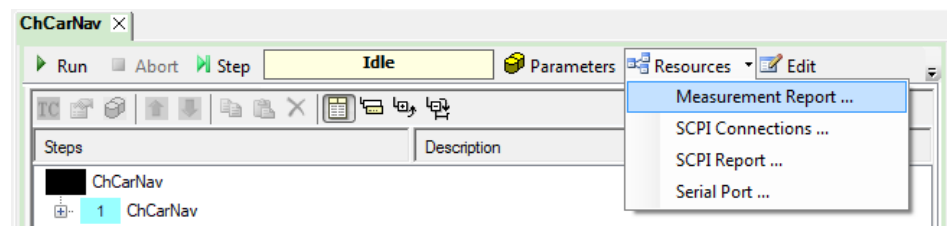
For a standard view of the measurement report, deselect "Treat "Ignored" as "Failed"" in the configuration dialog of measurement report, tab "Fail Options".



To access the measurement report configuration dialog, proceed as follows:

- a) To configure measurement report globally for all the tests, select "Resources" menu > "Measurement Report..."
- b) For only test plan-specific measurement report settings, double-click your test plan in the "File Browsers" on the left, the tab "Test Plans". On the test plan toolbar, select "Resources" menu > "Measurement Report..." -> button "Create Specific Settings".

The settings of the test plan specific resources are saved within the test plan.

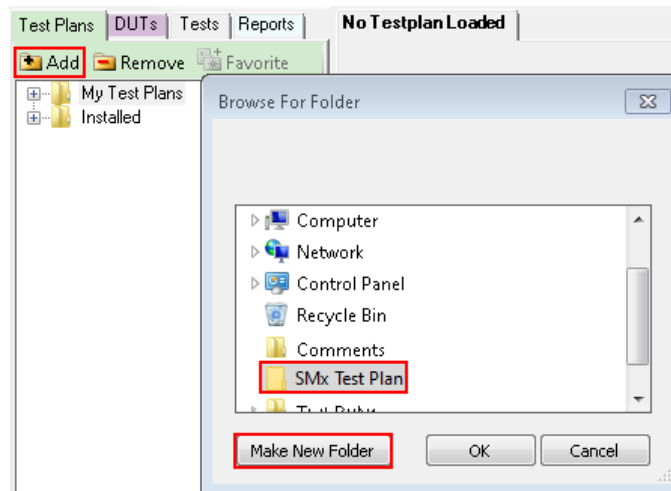


4.3 Preparation of DUT connection

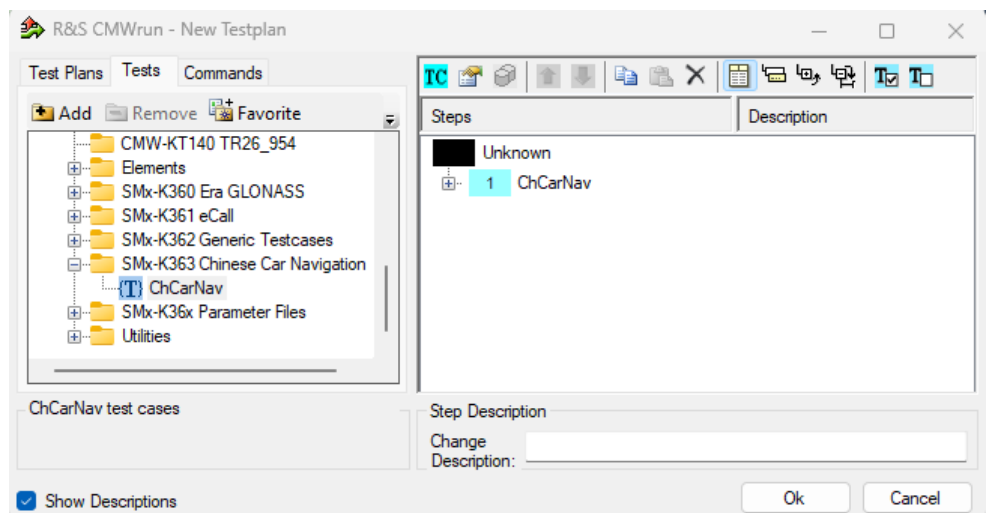
1. For the remote control of a DUT, configure the resource settings in "Resources" menu > "Serial Port". Use settings compatible to your DUT. Refer to the sequencer user manual, section Resources > Serial Port.
2. The following steps configure DUT attributes and properties.

Create your test plan:

- a) In the tab "Test Plans", specify a directory where you store your test plans.

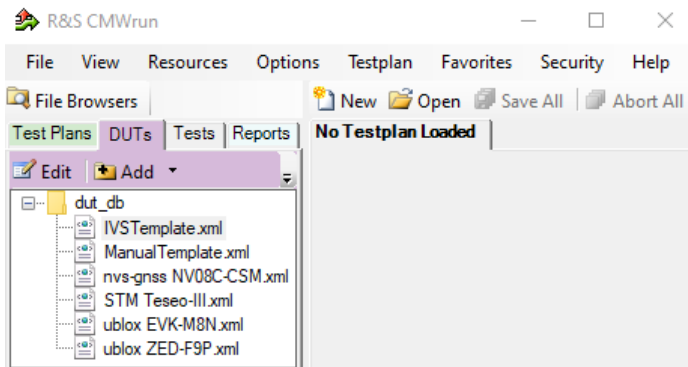


- b) Open the configuration dialog via "File" > "New Testplan...".
 c) In the tab "Test Plans", select your new test plan.
 d) In the tab "Tests", select the installed GNSS test plan.



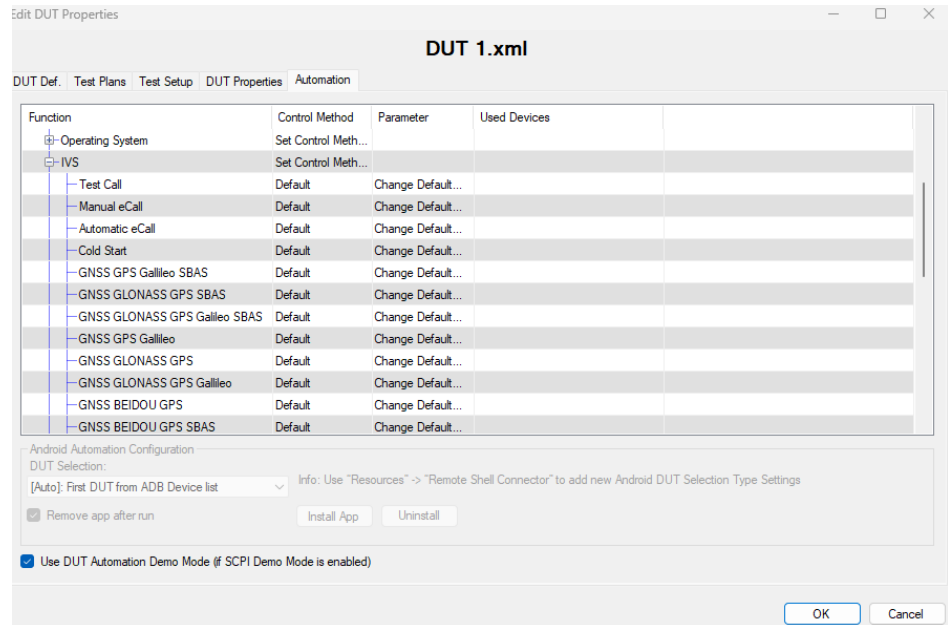
- e) Press "OK".
3. **Save your test plan** in the directory created in [step 2](#).
 4. **Prepare your DUT's file:**

- a) In the tab "DUTs", you find several predefined DUT's configurations. To create your own, double-click `IVSTemplate.xml` to open the configuration dialog "Edit DUT Properties".



- b) Modify "Manufacturer" entry to assign DUTs name. Otherwise, you overwrite the predefined template.

- c) In the tab "Automation", configure the DUT-related automation methods that are used for DUTs commands.
See also section DUT Files and Automation of the R&S CMWrun base manual.



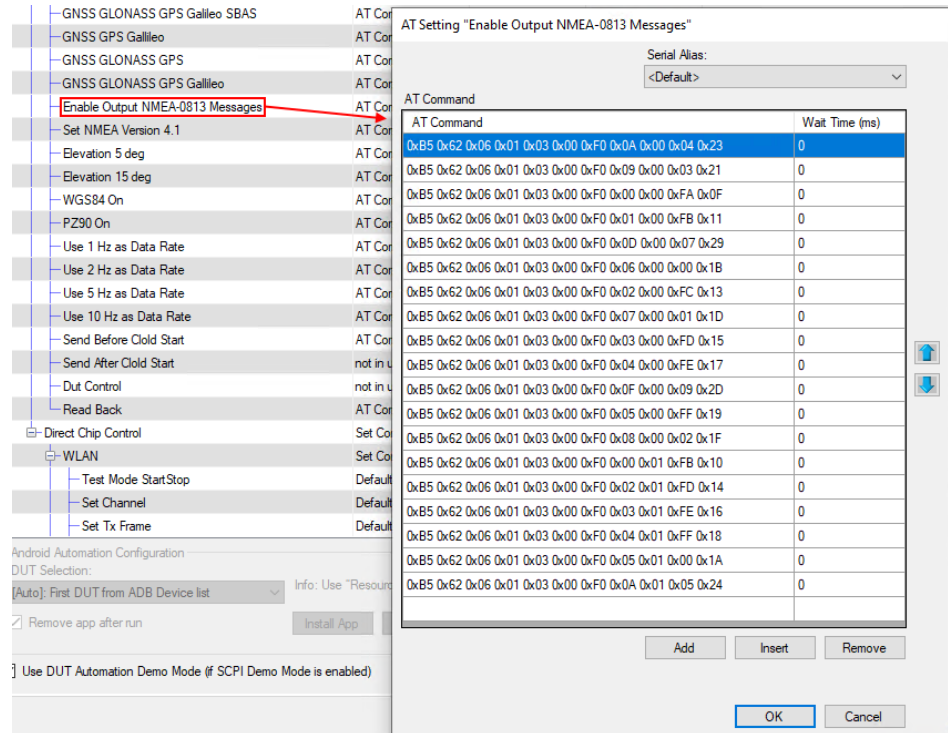
The test module supports the AT commands via COM ports and ADB commands. You can also mix control methods, e.g., ADB shell command sending with COM port NMEA reading. The default port is specified via Resources > Serial Port.

Set all commands for which parameters are available. Furthermore, it is important to set the control method for the "DUT" -> "Read Back" function to read the NMEA stream properly.

For AT commands, map the serial ports accordingly to bi-directional or two-way usage.

- Bidirectional: sets a common serial port for DUT configuration and the transmission of NMEA messages.
- Two-way: configures two serial ports to separate the control connection and the connection for NMEA data.

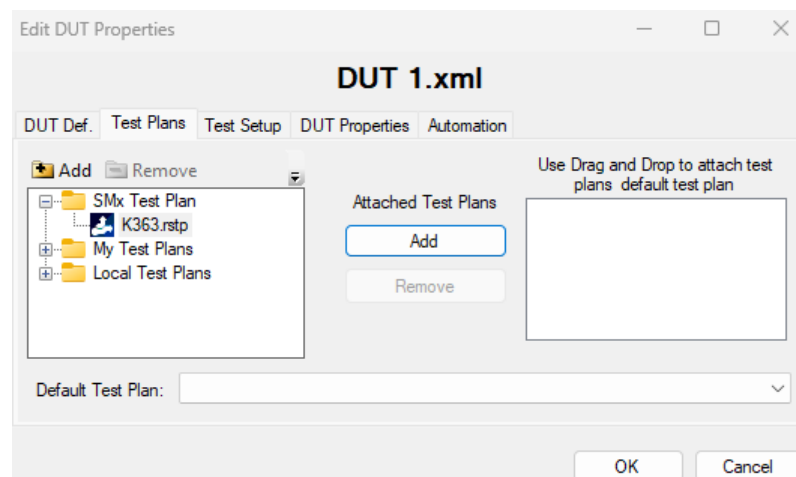
- d) Each DUT command is connected to a new row in the corresponding dialog. A waiting time after the execution can be set for each single command. Set also not needed commands to "not in use" to avoid automated stops for manual input. ASCII or hexadecimal notations are supported.



- e) Set all needed commands to control method "default"
 f) Set all not needed commands to control method "not in use"
 During test case execution, only command requests for all "default" commands show up

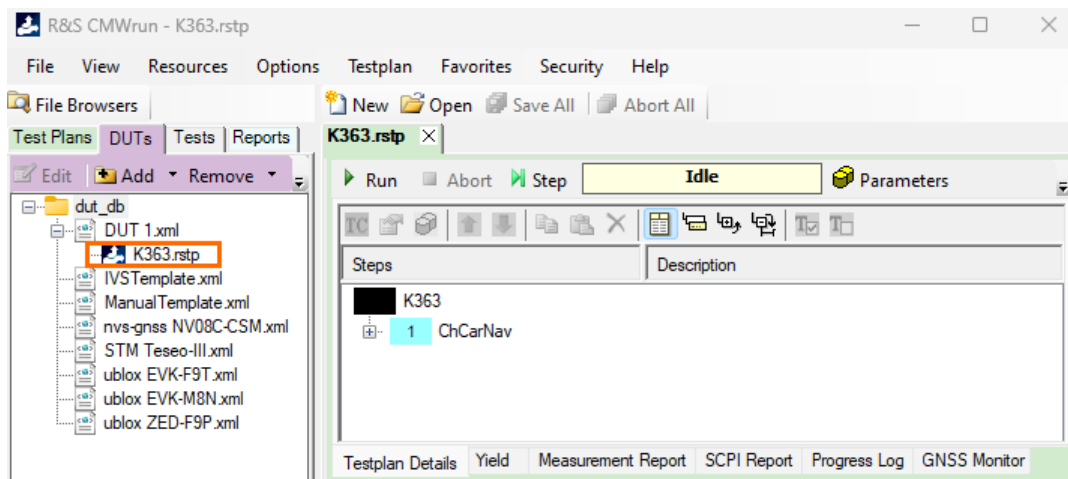
5. Assign a test plan to a DUT:

In the tab "Test Plans", select your test plan created in [step 2](#). Select "Add" and "OK".



Your test plan is now assigned to your DUT.

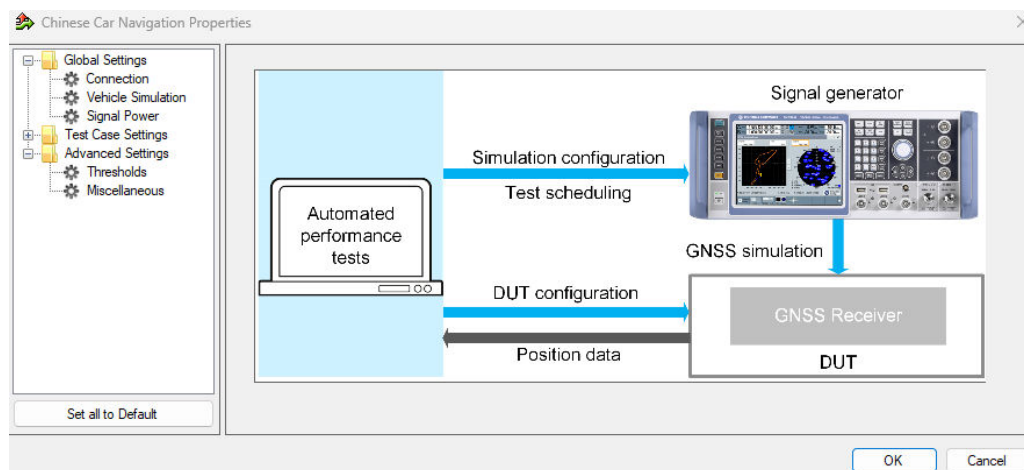
6. Always start your tests from the tab "DUTs" by double-clicking a test plan assigned to your DUT. It guarantees that the test plan executes the vendor-specific commands of your DUT. Otherwise, the test plan is aborted with the error "DUT type not found".



5 Test configuration

The property dialog box leads you to individual test configuration dialogs.

You can open the property dialog box from the "Testplan Details" subtab. Double-click the node, for example 1. Or select the node and click "Properties ...".



The property dialog box lists global settings, test case-specific settings for all supported GNSS test cases from test specifications, and advanced settings for non-conformance settings.

"Set all to Default" resets all settings: global settings, the settings of all test cases, and advanced settings.



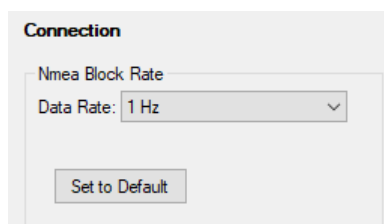
Changing the default settings results in deviation from the recommendations of test specifications. Any such change is indicated in the measurement report. Test specification parameter values are always shown in the SCPI report.

Use the navigation tree on the left, to open the corresponding configuration dialog. For description, refer to the following sections.

- [Connection setting](#)..... 16
- [Vehicle simulation setting](#).....17
- [Signal power setting](#).....19
- [Test case setting](#)..... 20
- [Advanced settings](#).....22

5.1 Connection setting

Specifies the data rate for NMEA stream transmitted by the GNSS generator.



Connection

Nmea Block Rate

Data Rate: 1 Hz

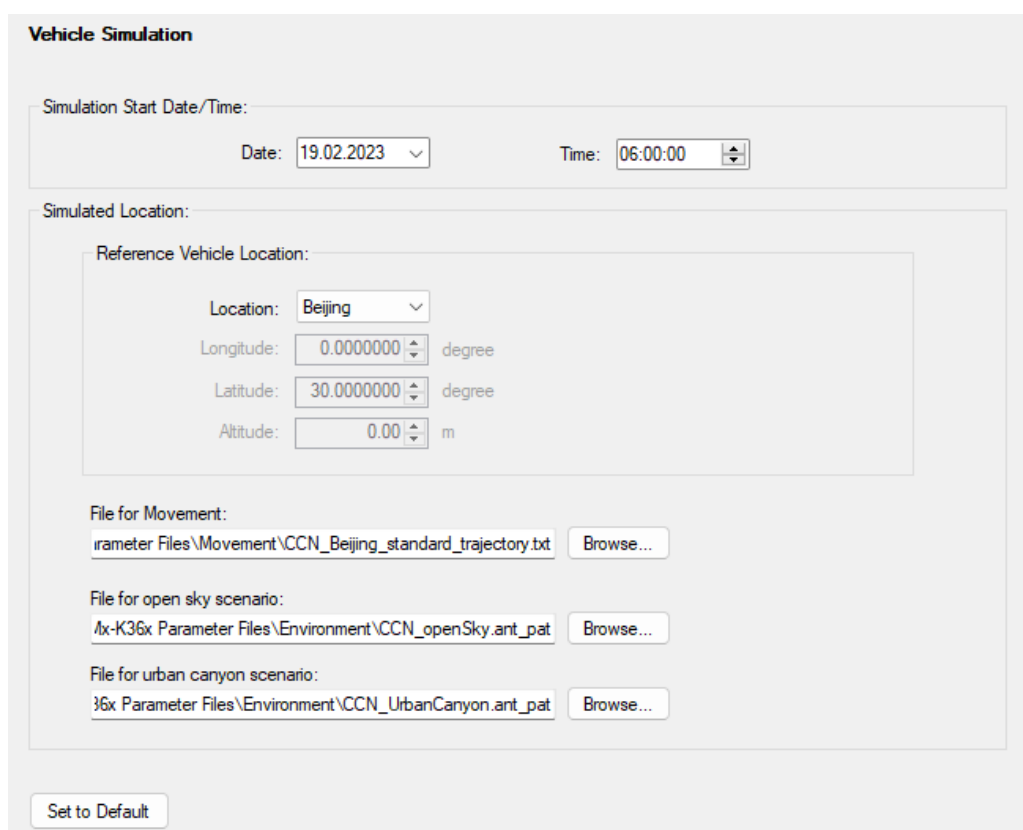
Set to Default

Set to Default

Resets all settings in the dialog.

5.2 Vehicle simulation setting

The dialog specifies the geo-position of the IVS and simulates its movement.



Vehicle Simulation

Simulation Start Date/Time:

Date: 19.02.2023 Time: 06:00:00

Simulated Location:

Reference Vehicle Location:

Location: Beijing

Longitude: 0.0000000 degree

Latitude: 30.0000000 degree

Altitude: 0.00 m

File for Movement:
parameter Files\Movement\CCN_Beijing_standard_trajectory.txt Browse...

File for open sky scenario:
4x-K36x Parameter Files\Environment\CCN_openSky.ant_pat Browse...

File for urban canyon scenario:
36x Parameter Files\Environment\CCN_UrbanCanyon.ant_pat Browse...

Set to Default

Simulation Start Date/Time

Specifies the time signaled within the generated positioning data.

Reference Vehicle Location

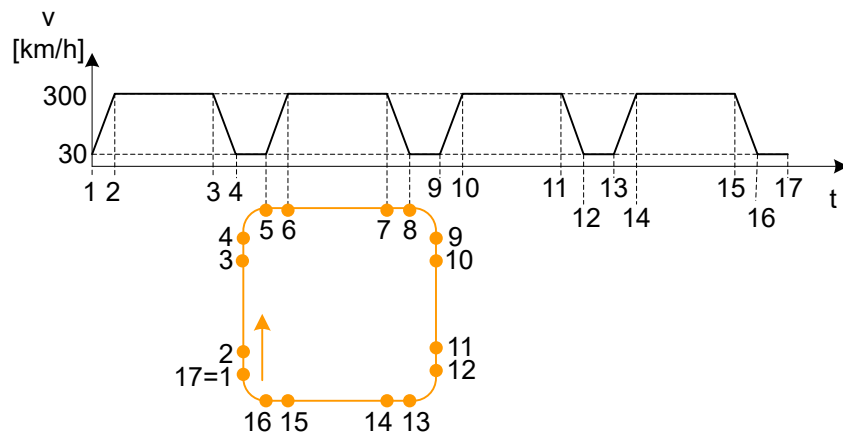
Specifies the IVS location. Select the predefined location or specify the geographical position manually in coordinate system WGS84.

Files for Movement and Visibility

Selects files with predefined movement geo-coordinates.

The following files complying with the specification are provided in the installation package:

- `CCN_Beijing_standard_trajectory.txt` for full reception, starting in Beijing, China, square-similar trajectory with changing velocity

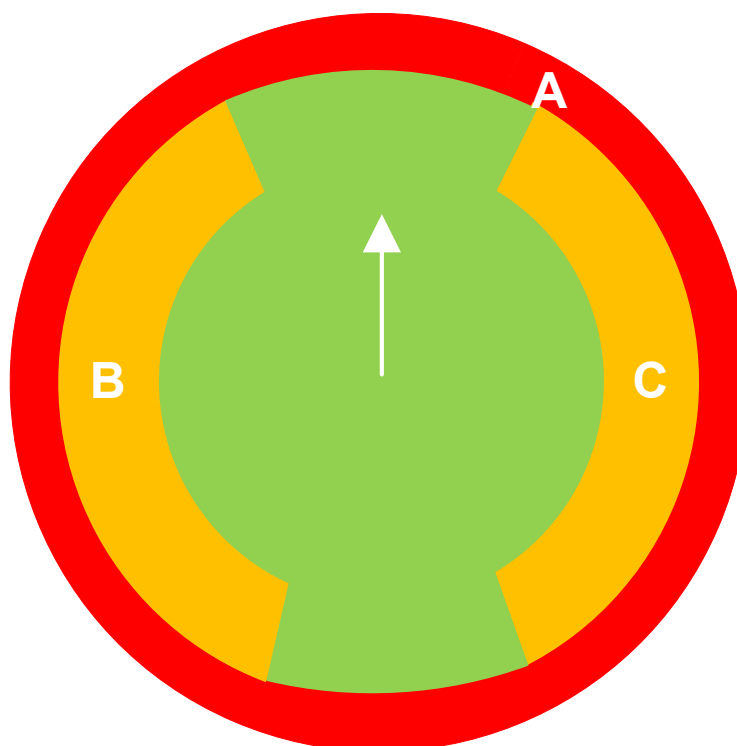


- `CCN_openSky_antenna_pat`

Table 5-1: Predefined open sky pattern

Area	Elevation	Azimuth	Attenuation	Description
A	0° to 5°	0° to 360°	≤ -100 dB	no signal
Outside of area A	remaining	0° to 360°	0 dB	open sky

- `CCN_UrbanCanyon.ant_pat` for poor reception, e.g., between two buildings, with the following antenna pattern:



The file is suitable for test case 4.

Table 5-2: Predefined urban canyon pattern

Area	Elevation	Azimuth	Attenuation	Description
A	0° to 5°	0° to 360°	≤ -100 dB	no signal
B	5° to 30°	210° to 330°	-40 dB	shield to the left
C	5° to 30°	30° to 150°	-40 dB	shield to the right
Outside of areas A, B, C	remaining	remaining	0 dB	open sky

Set to Default

Resets all settings in the dialog.

5.3 Signal power setting

Configures RF power.

Signal Power

Received Satellite Power:

GPS: -130.0 dBm

BDS: -130.0 dBm

Galileo: -130.0 dBm

GLONASS: -130.0 dBm

External Power Attenuation: 0.0 dB

Set to Default

Received Satellite Power

Specifies the power of GPS, BeiDou, Galileo, or GLONASS satellites. There are six simulated visible satellites per GNSS system.

The power can be changed for each GNSS system individually.

External Power Attenuation

Specifies external power attenuation.

External attenuator is recommended for levels below -120 dBm for the following reasons:

- The level uncertainty increases for lower levels
- The maximum attenuation of the internal step attenuator is -150 dBW. Lower levels are achieved by reducing the internal amplification. The signal level goes down, but the noise floor remains at a constant level. Applying an external attenuator instead decreases the signal level and the noise floor to the same degree, thus maintaining the dynamic range.
- The minimum of the level setting range is -200 dBW. Attenuators are the only way to reach even lower levels

Refer to [Chapter 3, "Test setup"](#), on page 8.

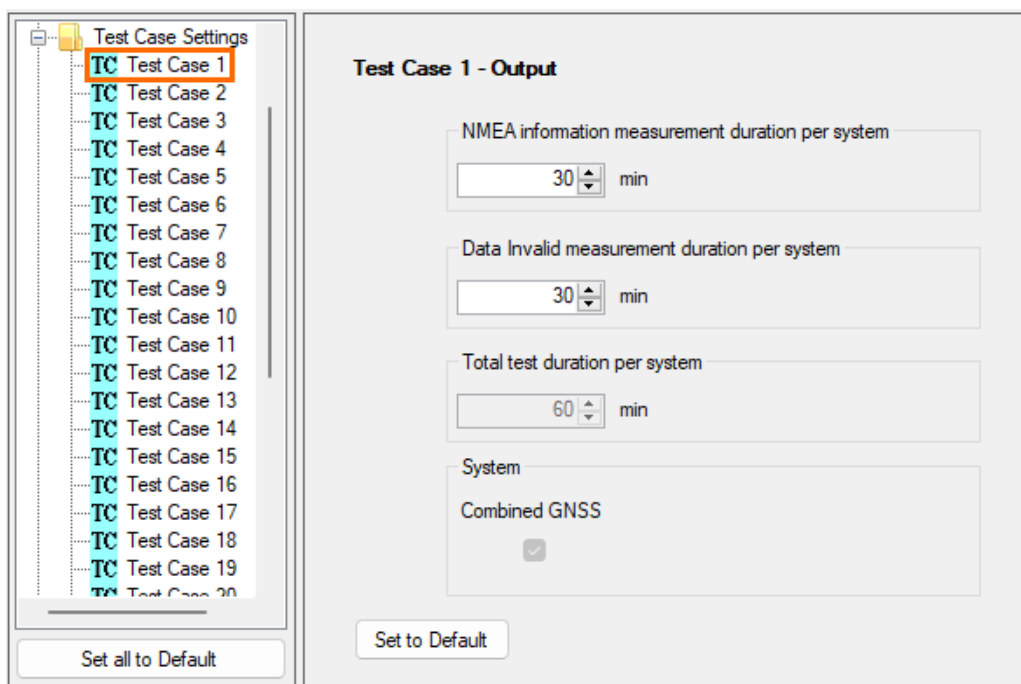
Set to Default

Resets all settings in the dialog.

5.4 Test case setting

The dialog box lists all supported test cases from the selected test specification.

Click an individual test case to the left, to open the corresponding configuration dialog. Most of the signal settings are by default according to the test specification.



Several test cases contain self-explanatory settings as "Measurement duration per system".

The following description covers only the remaining settings.

Capability.....	21
Data invalid measurement duration per system.....	21
NMEA information measurement duration per system.....	21
Power.....	22
Set to Default.....	22
System.....	22
Total test duration per system.....	22

Capability

Enables optional testing of the timing accuracy with an oscilloscope R&S RTM3002 or R&S RTM3004.

To use an oscilloscope, add the SCPI connection for RTM according to [Chapter 4.2, "Preparation of instrument connection"](#), on page 9.

The PPS test runs optionally within tests 27 to 30 according to specification "Technical specification for on board satellite positioning system", annex F.2, Data Processing Method of Timing Accuracy.

The PPS test duration is 24h.

Data invalid measurement duration per system

Sets the test duration of the transmission of an invalid NMEA message.

NMEA information measurement duration per system

Sets the test duration per GNSS system for the testing of NMEA transmission from the DUT.

Power

The initial power in the acquisition phase.

Set to Default

Resets all settings in the dialog.

System

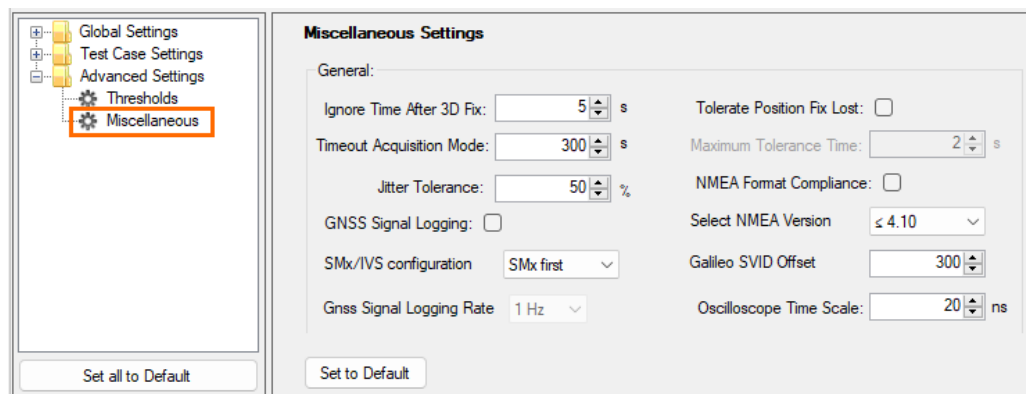
- **Combined GNSS:** GPS, BeiDou, Galileo, and GLONASS - six simulated visible satellites per GNSS system.
The signals are generated within the following bands: GPS L1, BDS B1I, Galileo E1, and GLONASS L1 (G1).
- **BDS:** six simulated BeiDou satellites, band BDS B1I.

Total test duration per system

Specifies the total time for each subtest per GNSS system including waiting time (e.g. for acquisition).

5.5 Advanced settings

The following section specifies the settings to speed up the tests or to loosen the strict limits and conditions.



The following parameters are configurable.

[Thresholds](#)..... 22

[Miscellaneous Settings](#)..... 22

[Set to Default](#)..... 23

Thresholds

Specifies and enables different test limit values than defined in the specification. These settings change the criteria of pass/fail verdict, therefore they are password protected.

Miscellaneous Settings

Specifies the general signal and measurement settings.

- **Ignore time after 3D fix:** the time when the coordinates calculated by receivers are ignored in the test case for some time after the first 3D fix is attained. Some

receivers make a fix far away from the true location and converge to that point after a couple of seconds. This setting can bias the error statistics and can be increased for more stability of the results.

- **Timeout acquisition mode:** maximum time duration after that the IVS has to acquire satellite signals
- **Jitter tolerance:** maximal jitter allowed for the transmission of NMEA block related to the NMEA rate.
Example:
When the value is 50%, the rate is 1 Hz (duration = 1 s) and the consecutive blocks are received within 0.5 to 1.5 seconds, then the rate is good.
- **GNSS signal logging:** enables or disables the GNSS signal logging at the R&S CMWrun.
- **SMx/IVS configuration:**
 - "Parallel": the configurations of the instrument and the DUT are started in parallel
 - "SMx first": the instrument is configured first, afterwards the DUT is configured
- **GNSS signal logging rate:** sets the rate for GNSS signal logging at R&S CMWrun.
- **Tolerate position fix lost, maximum tolerance time:** allows the 3D fix to be lost and sets its maximum time duration
- **NMEA format compliance:** if enabled, the strict format compliance of the DUTs messages with NMEA standard is required to pass the test
- **Select NMEA version:**
 - NMEA version 4.10 uses system ID to distinguish between GPS and Galileo satellites
 - NMEA 4.00 and older: No specified Galileo support by NMEA specification. Galileo ID offset is necessary to distinguish GPS and Galileo.
- **Galileo SVID offset:** offset useful to distinguish between GPS and Galileo satellites in NMEA versions < 4.10
- **Oscilloscope time scale:** scaling of x-axis for the time granularity of timing performance tests (tests 27 to 30) with an RTM oscilloscope. This setting has a significant effect to the measurement accuracy.

Set to Default

Resets all settings in the dialog to the values required by the test specification.

6 Test results

The measurement report contains results, one table for each executed test case. The tables list the test items and conditions, the performed test steps, their results and pass/fail verdicts.

ChCarNav: Test Case 1 - Output

<i>Test Items and Conditions</i>	Threshold	Result	Unit	Status
DUT: ublox EVK-F9T				
Average NMEA-0183 Sentence rate 10.00 Hz <i>Gps/Glonass/Galileo/Beidou</i>	50 <= ms <= 150	100	ms	
NMEA-0183 Format: GGA <i>Gps/Glonass/Galileo/Beidou</i>		OK		
NMEA-0183 Format: GSA <i>Gps/Glonass/Galileo/Beidou</i>		OK		
NMEA-0183 Format: GSV <i>Gps/Glonass/Galileo/Beidou</i>		OK		
NMEA-0183 Format: RMC <i>Gps/Glonass/Galileo/Beidou</i>		OK		
NMEA-0183 Format: VTG <i>Gps/Glonass/Galileo/Beidou</i>		OK		
NMEA-0183 Format: GGA Invalid check <i>Gps/Glonass/Galileo/Beidou</i>		OK		
NMEA-0183 Format: GSA Invalid check <i>Gps/Glonass/Galileo/Beidou</i>		OK		
NMEA-0183 Format: RMC Invalid check <i>Gps/Glonass/Galileo/Beidou</i>		OK		
NMEA-0183 Format: VTG Invalid check <i>Gps/Glonass/Galileo/Beidou</i>		OK		
Test result				Passed

ChCarNav: Test Case 2 - Consistency of supported satellite signals

<i>Test Items and Conditions</i>	Threshold	Result	Unit	Status
DUT: ublox EVK-F9T				
NMEA-0183 Format: GSA gives the satellites with better signal <i>Gps/Glonass/Galileo/Beidou</i>		OK		
NMEA-0183 Format: GSV output the received satellite information of <i>Gps/Glonass/Galileo/Beidou</i>		OK		
Test result				Passed

The last table lists all errors and warnings collected during the test execution.