R&S®SMBV-K361, R&S®SMBVB-K361, R&S®SMW-K361
eCall Test Suite
User Manual

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This manual describes the following R&S®CMWrun option for software version 1.9.6 or higher:

- R&S®SMBV-K361 (eCall test suite)
- R&S®SMBVB-K361 (eCall test suite)
- R&S®SMW-K361 (eCall test suite)

Contents

1 R&S SMx-K361 eCall Test Suite

The following sections describe the test suites R&S SMx-K361 for eCall 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 selected test specification as possible.

The following standards are supported:

- European Union regulation 2017/79, annex VI, Technical requirements for compatibility of eCall in-vehicle systems with the positioning services provided by the Galileo and the EGNOS systems
- United Nations regulation ECE/TRANS/WP.29/GRSG/2017/12, annex 8, Test methods for the navigation solutions

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	Test purpose
1. Verify NMEA transmission from DUT	Checks that the GNSS receiver outputs the navigation parameter data to external devices in NMEA-0183 format
2. Location accuracy (static receiver)	Estimates the error in the evaluation of the plane view and altitude in the autonomous static mode. A static location is simulated and the error between actual and determined location is calculated
3. Location accuracy (moving receiver) open sky	Estimates the error in the evaluation of the plane view, altitude and velocity in the dynamic mode. A certain trajectory is simulated and the error between actual and determined location as well as the velocity error is calculated
4. Location accuracy (moving receiver) intermitted reception and urban canyon	Estimates the error in the evaluation of the plane view, altitude and velocity in the dynamic mode with signal impairments. A certain trajectory is simulated, signal is faded and partly blocked. The velocity error and the error between actual and determined location as well as the velocity error is calculated
5. Time-to-first fix (TTFF) under cold start conditions	Determines the time to first navigation fix for a reset receiver. The ephemeris and almanac data from all satellites are cleared and thus, the receiver has to gain all data and the time to first fix is measured. One measurement step comprises signal acquisition at the TX level of -130 dBm and the cold start of the DUT, until it can acquire the signal again. The cold start is executed with specified repetitions. The same is executed with the TX level of -140 dBm. The averaged measurement time must not exceed 60 s for the signal level of -130 dBm and 300 s the signal level of -140 dBm.

Test case	Test purpose
6. Reacquisition time	Evaluates the restore time for signal tracking for a certain GNSS constellation after tracking was lost due to signal blockage. To simulate blockage, the radio frequency signal is switched off for a specified time and the recovery time is measured after the signal was switched on. One measurement step comprises signal off, signal on, until the DUT can acquire the signal again. Each step is executed with specified repetitions.
7. Tracking and acquisition sensitivity	Verifies the sensitivity of the GNSS navigation module in signal acquisition mode and in tracking mode. The acquisition time is measured with the signal level of -144 dBm. The tracking time is measured with the signal level of -155 dBm. The reacquisition time is measured after configurable signal blockage with the signal level of -150 dBm. The acquisition, tracking and reacquisition time must be within the required limits of $\leqq$3600 s for $T_{Acquisition}$, $\geqq$600 s for $T_{Tracking}$, and $\leqq$60 s for $T_{Reacquisition}$.

1.1 Prerequisites

Required equipment for **R&S SMBV-K361**:

- R&S SMBV100A for GNSS simulation must be equipped with the following options:
  Hardware:
    - HW option R&S SMBV-B10
    - HW option R&S SMBV-B103/-B106

  Minimum required options:
    - R&S SMBV-K44, GPS
    - R&S SMBV-K66, GALILEO
    - R&S SMBV-K91/-K96, extension to 12 / 24 satellites
    - R&S SMBV-K92, GNSS enhanced (motion files, atmospheric effects)
    - R&S SMBV-K110, SBAS

  Additional options for full test coverage:
    - R&S SMBV-K102, antenna pattern and R&S SMBV-K103, spinning and attitude simulation for test location accuracy with moving receiver (2.4) - test mode poor reception
    - R&S SMBV-K94, GLONASS for testing in line with UN specification (2.1 to 2.7)
- R&S CMWrun base software, version 1.8.10 or higher.
  No smart card and no licenses are required for R&S CMWrun.

Required equipment for **R&S SMBVB-K361**:

- 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-K44, GPS
    - R&S SMBVB-K66, GALILEO

    – R&S SMBVB-K106, SBAS

Additional options for full test coverage:

    – R&S SMBVB-K108, antenna pattern, spinning and attitude simulation for test location accuracy with moving receiver (2.4) - test mode poor reception

    – R&S SMBVB-K94, GLONASS for testing in line with UN specification (2.1 to 2.7)

- R&S CMWrun base software, version 1.9.6 or higher.
  No smart card and no licenses are required for R&S CMWrun.

Required equipment for **R&S SMW-K361**:

- 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-B103/-B203

Minimum required options:

    – R&S SMW-K44, GPS

    – R&S SMW-K66, GALILEO

    – R&S SMW-K106, SBAS

Additional options for full test coverage:

    – R&S SMW-K108, antenna pattern, spinning and attitude simulation for test location accuracy with moving receiver (2.4) - test mode poor reception

    – R&S SMW-K94, GLONASS for testing in line with UN specification (2.1 to 2.7)

- R&S CMWrun base software, version 1.9.5 or higher.
  No smart card and no licenses are required for R&S CMWrun.

1.2 Test Setup

The following figure provides an overview of the test setup. In this example, the instrument R&S SMBV100A is used. The test setup with another supported instrument is similar.
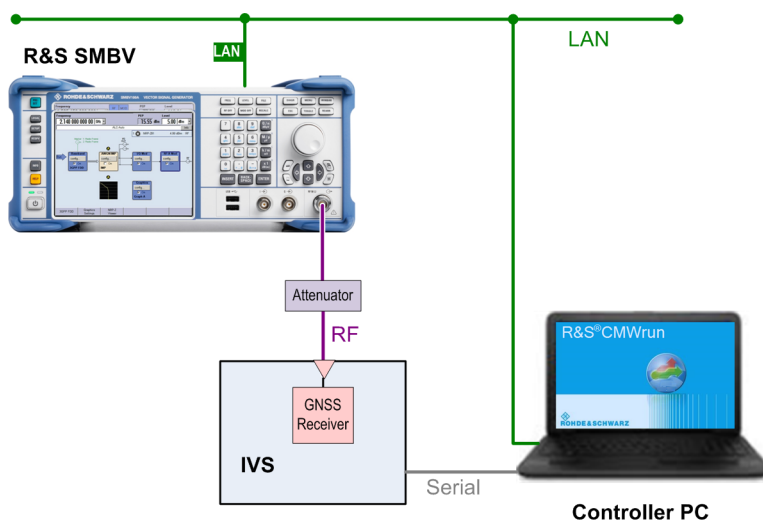
The test setup comprises the following components:

- An instrument, providing GNSS signals to the IVS for positioning.
  Connect the RF output port of the instrument to the RF port of the IVS (GNSS receiver).
- A computer executing the R&S CMWrun.
  The computer controls the instrument via SCPI connections (typically LAN). It controls the IVS 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 16.

1.3 System Configuration

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

1.3.1 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-K361 eCall test suite.

Refer to the sequencer user manual, section Installation.

Ignore the message indicating no license is found.

### 1.3.2 Preparation of Instrument Connection

1. For remote control of the instrument, configure the resource settings "Resources" menu > "SCPI Connections". Configure the SCPI resource settings compatible to the test instrument. For the control of R&S SMBV, the entry with an alias "SMBV" is used. For the control of R&S SMW200A, the entry with an alias SMW is used. Refer to the sequencer user manual, section Resources > SCPI Connections.

2. Configure measurement report settings.
    For standard view of the measurement report, deselect "Treat "Ignored" as "Failed"" in the configuration dialog of measurement report, tab "Fail Options".
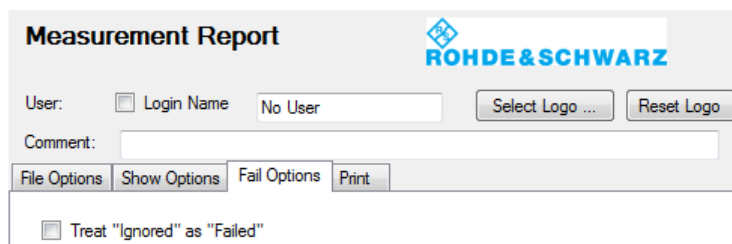
To access the measurement report configuration dialog, proceed as follows:

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...", use the button "Create Specific Settings".
   The settings of test plan specific resources are saved within the test plan.
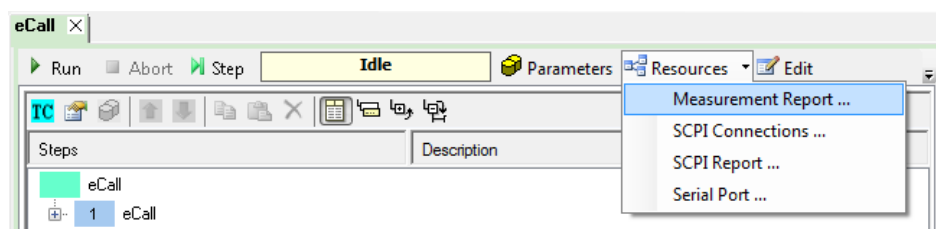

1.3.3 Preparation of IVS Connection

1. For the remote control of an IVS, configure the resource settings in "Resources" menu > "Serial Port". Use settings compatible to your IVS.
    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.
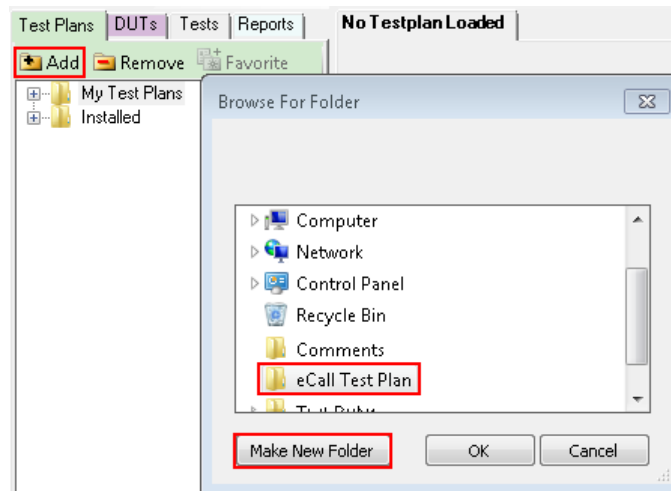
b) Open configuration dialog via "File" > "New Testplan...".
c) In the tab "Tests", select the installed eCall test plan.
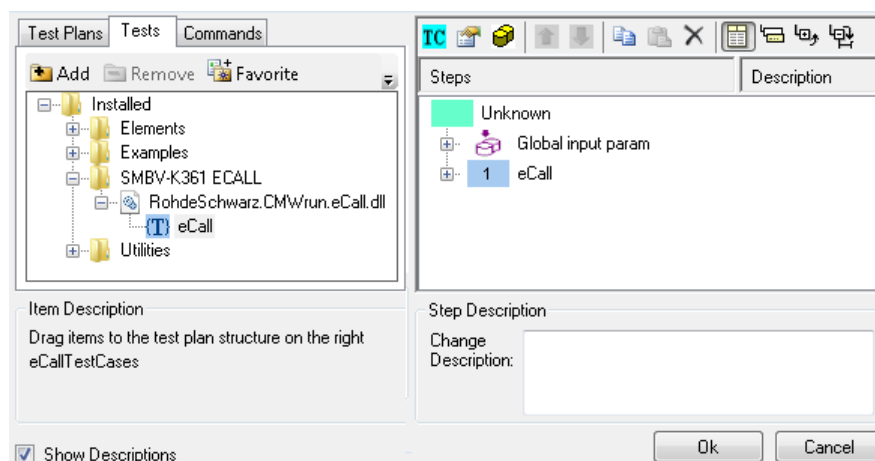
d) Press "OK".

3. **Save your test plan** in the directory created in step 2.

4. **Prepare your DUT's file for automated mode**:
    The following steps only apply if the vendor-specific commands control the DUT during the test execution.

    a) In the tab "DUTs", your find several pre-defined DUT's configurations. To create your own, double-click `IVSTemplate.xml` to open configuration dialog "Edit DUT Properties".
    b) Modify "Manufacturer" entry to assign DUTs name. Otherwise, you overwrite the pre-defined template.

c) In the tab "DUT Def.", table "Additional DUT Attributes", enter the vendor-specific commands of your DUT in the column "Data". Enter data in hexadecimal or ASCII format. Keep column "Item" unchanged.

	Item	Data
▶	IVS Cold Start	0xB5 0x62 0x06 0x04 0x04 0x00 0xFF 0xFF 0x02 0x00 0x0E
	IVS Elevation 5 deg	0xB5 0x62 0x06 0x24 0x24 0x00 0x02 0x00 0x00 0x03 0x00
	IVS Elevation 15 deg	0xB5 0x62 0x06 0x24 0x24 0x00 0x02 0x00 0x00 0x03 0x00
	IVS WGS84 on	
	IVS PZ90 on	
	Send before Cold Start 1	0xB5 0x62 0x06 0x01 0x03 0x00 0xF0 0x0A 0x01 0x05
	Send after Cold Start 1	
	DUTControl	Automatic
✳		

Additional DUT Attributes:

Tip:
- You can use several commands in one line, separated by semicolon**;**
- You can add time delay in ms using `WAIT(<delay>)` command.

Send before Cold Start 1	$PSTMSETPAR,1261,3;$PSTMSAVEPAR;WAIT(1000);$PSTMSRR;WAIT(5000)

Figure 1-1: Example

d) Ensure, that data of item "DUTControl" remains empty or is set to "Automatic".

5. **Prepare your DUT's file for manual mode**:
   The following steps only apply if you control the DUT manually during the test execution.

   a) In the tab "DUTs", double-click `ManualTemplate.xml` to open configuration dialog "Edit DUT Properties".
   b) Modify "Manufacturer" entry to assign DUTs name. Otherwise, you overwrite the pre-defined template.
   c) In the tab "DUT Def.", table "Additional DUT Attributes", ensure, that data of "DUTControl" is set to "Manual". With this mode, all other settings in column "Data" are ignored. Pop-up windows prompt you to send DUT commands to the IVS manually during the test execution.

Additional DUT Attributes:

|	Item	Data
▶	DUTControl	Manual
✳		

6. **Assign a test plan to a DUT**:
   In the tab "Test Plans", select your test plan created in step 2. Select "Add" and "OK".
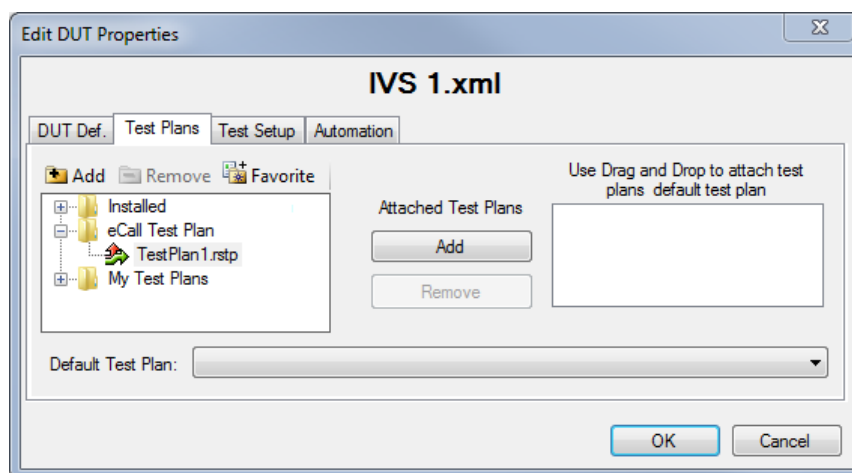
Your test plan is now assigned to your DUT.

7. 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".
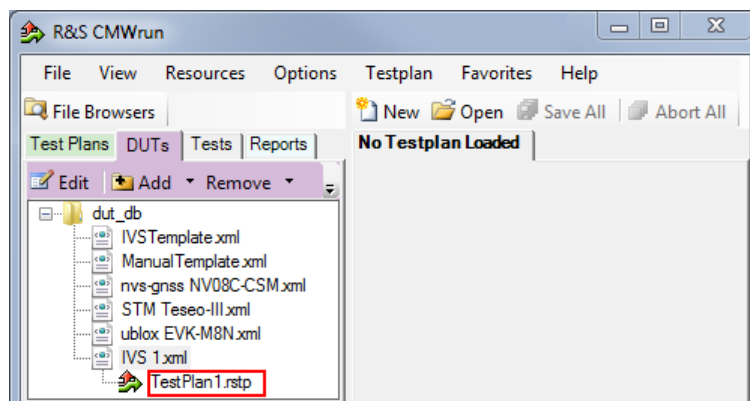
1.4 Test Configuration

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 [image] "Properties ...".
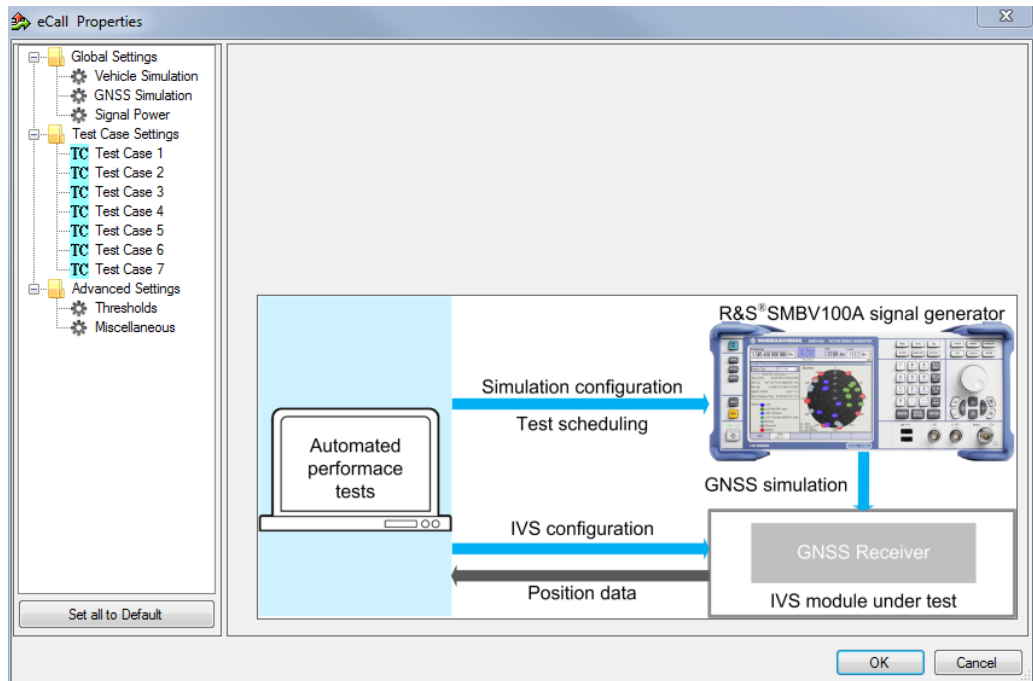
The property dialog box lists global settings, test case-specific settings for all supported eCall test cases from test specifications, and advanced settings for non-conformance settings.

"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 SCPI report.

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

1.4.1 Vehicle Simulation Setting

Specifies the geo-position of the IVS and simulates its movement.

Simulation Start Date/Time
Specifies the time signaled within the generated positioning data.

Fixed Vehicle Location
Specifies the IVS location for the tests on stationary vehicles. Select predefined location or specify geographical position manually in coordinate system WGS84.

Files for Movement and Visibility
Selects files with predefined movement geo-coordinates. The files are used by the test case 3 and 4, see .

The following files complying standard are provided in the installation package:
● `eCallT3_T4.txt` for full reception, starting in Moscow, elliptical trajectory with changing velocity
  The file is suitable for test cases 3 and 4.
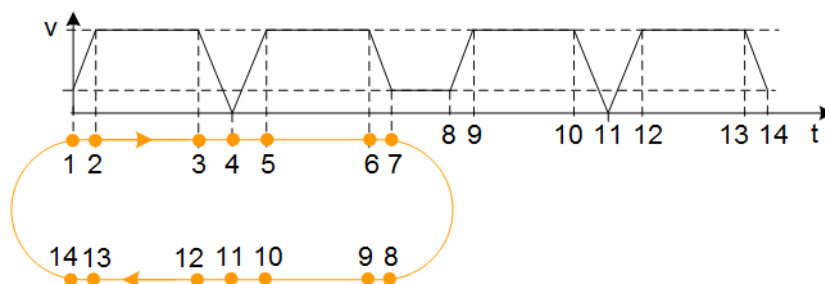
- `eCallUrbanCanyon.ant_pat` for poor reception, e.g., between two buildings, with the following antenna pattern:
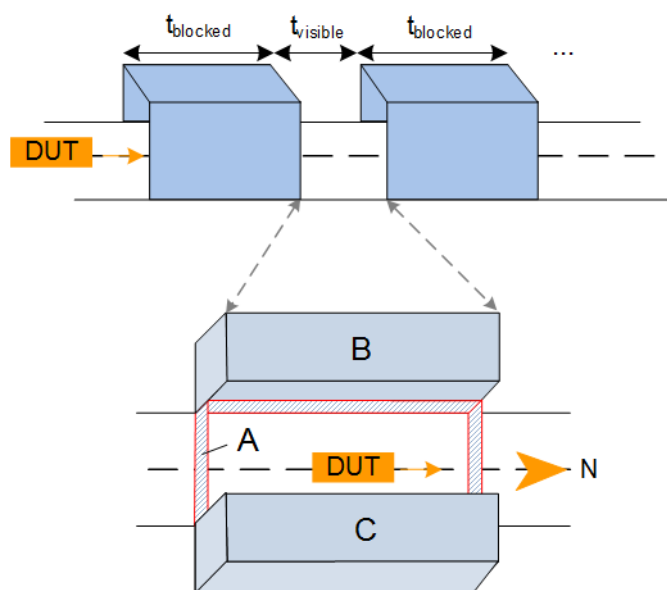
The file is suitable for test case 4.

Table 1-2: Predefined urban canyon

Zone	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 west
C	5° to 30°	30° to 150°	-40 dB	Shield to the east
	remaining	remaining	0 dB	Open sky

Set to Default
Resets all settings in the dialog including pre-defined files.

1.4.2 GNSS Simulation Setting

Defines standard to be followed during the measurements.
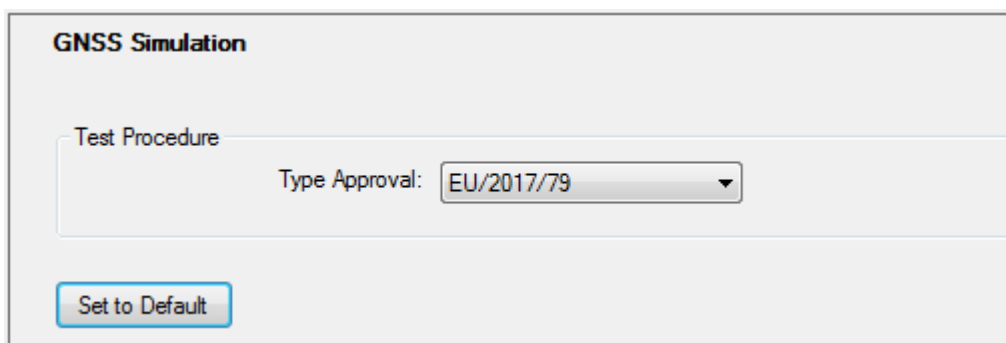
Test Procedure

Selects the standard:

- European Union regulation 2017/79, annex VI, Technical requirements for compatibility of eCall in-vehicle systems with the positioning services provided by the Galileo and the EGNOS systems
- ECE/TRANS/WP.29/GRSG/2017/12, annex 8, Test methods for the navigation solutions

Set to Default

Resets all settings in the dialog.

1.4.3   Signal Power Setting

Configures RF power.
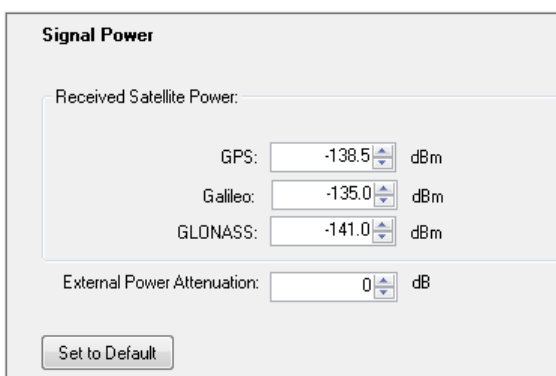
Received Satellite Power

Specifies the power of one GPS, Galileo, and for ECE/TRANS/WP.29 tests also GLO-NASS satellite.

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 1.2, "Test Setup", on page 7.

Set to Default
Resets all settings in the dialog.

1.4.4 Test Case Setting

The dialog box lists all supported eCall 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.
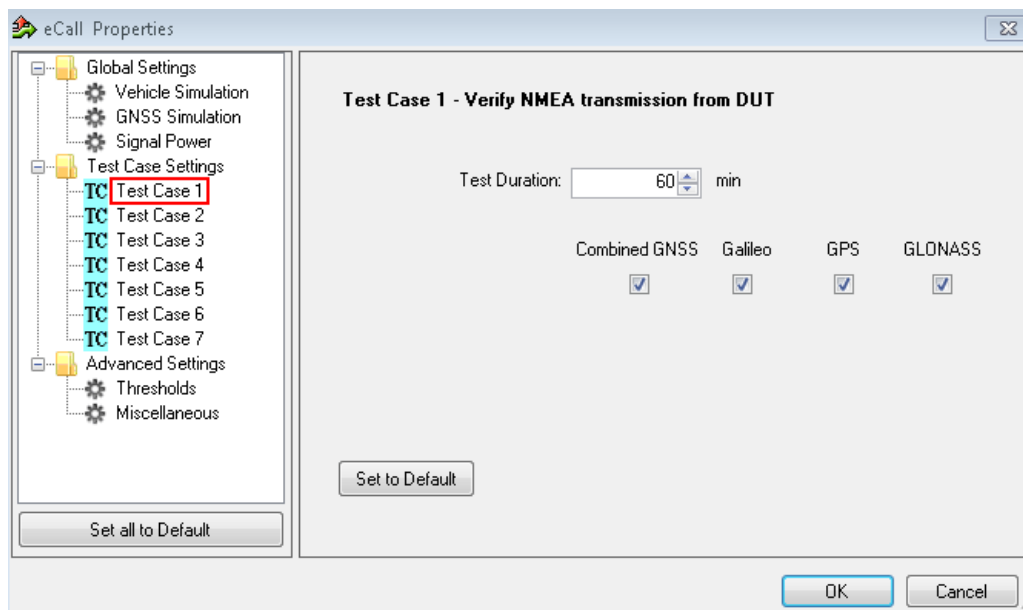
Several test cases contain self-explanatory settings as "Test Duration" or "Set to Default". In several test cases, you can select the satellite standards combined GNSS (Galileo/GPS/SBAS), Galileo, GPS, GLONASS, or any combination. Note, that GLONASS is only available for ECE/TRANS/WP.29 tests. The following description covers only remaining settings.

Test Cases 3 and 4

GUI enables the standards (combined GNSS, Galileo, GPS, GLONASS, or any combination) to be tested.

The displayed files contain signal characteristics for particular tests, refer to "Files for Movement and Visibility" on page 14.

The subtests are per default configured via the following configuration files:
- TC3: "Full Reception" test pre-configured via `eCallT3_T4.txt`.
- TC4: "Poor Reception" test pre-configured via `eCallT3_T4.txt` and `eCallUrbanCanyon.ant_pat`.

"Set to Default" does not reset the specified files. You can reset all files to the predefined using "Set to Default" in "Vehicle Simulation" configuration dialog, see Chapter 1.4.1, "Vehicle Simulation Setting", on page 13. For general reset, you can also execute "Set all to Default" to the left at the bottom.

Test Case 7

One measurement step comprises signal off, signal on, until the DUT can acquire the signal again. Each step is executed with the specified number of repetitions.

1.4.5 Advanced Settings

The following section specifies the settings to speed up the tests or to loosen the strict conformance limits and conditions. Note, that all default settings are according to the specification. For tests according to the specification, keep the advanced settings unchanged.
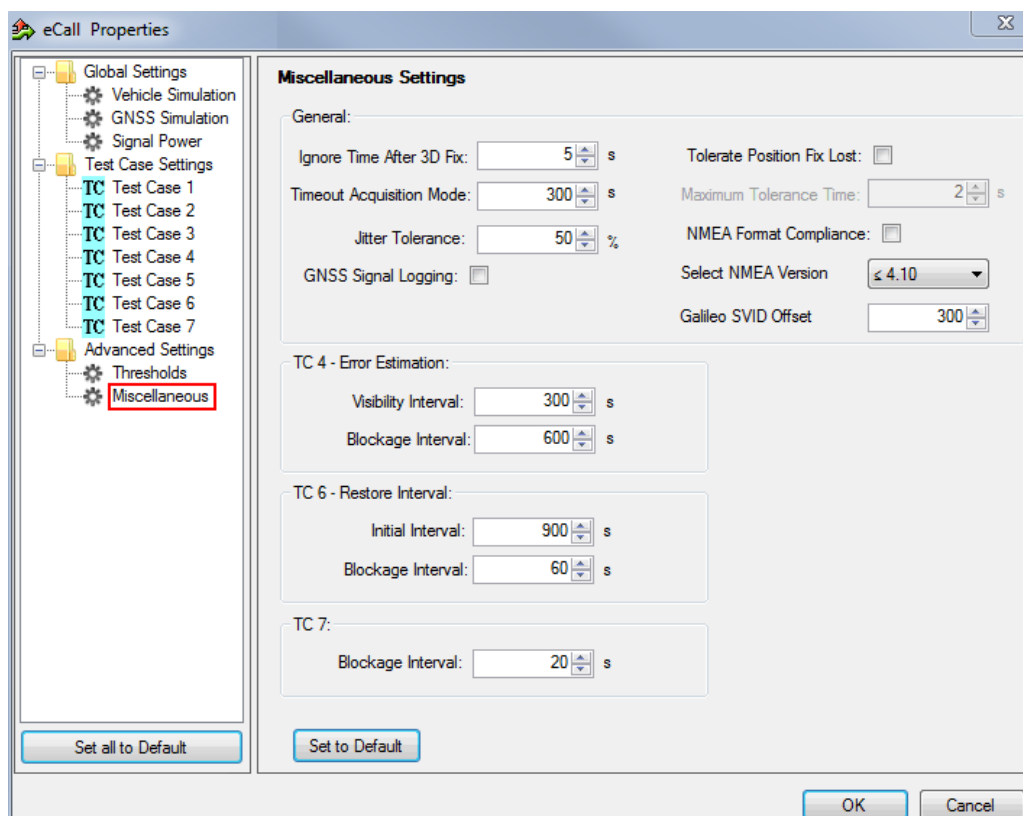
The following parameters are configurable.

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

Miscellaneous
Specifies the settings for non-conformance tests.

General ← Miscellaneous
- **Ignore time after 3D fix**: the time where 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 the true location and converge to that point after 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
- **GNSS signal logging**: If enabled, the results with NMEA sentence are stored in log file in the instrument directory `/hdd/Gnss_Gen/Log`.
- **Tolerate position fix lost**: 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

TC 4 Error Estimation ← Miscellaneous

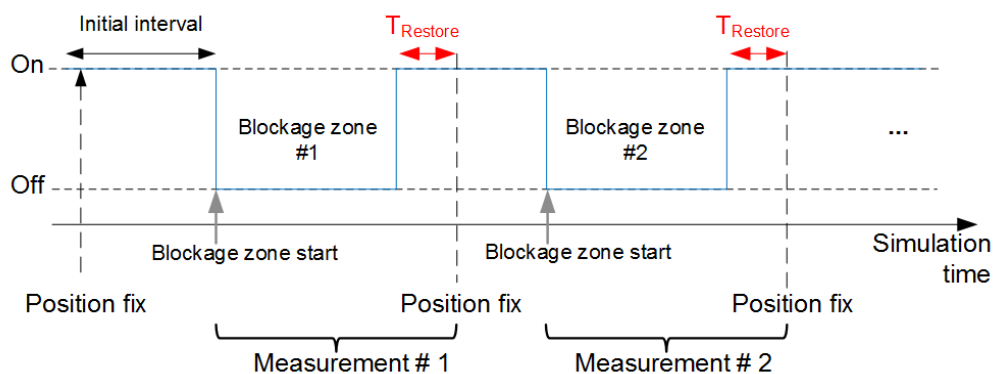Specifies visibility and blockage intervals for TC 4 combined with urban canyon pattern, see Chapter 1.4.1, "Vehicle Simulation Setting", on page 13.
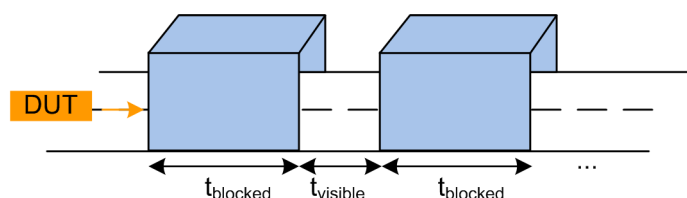
TC 6 Restore Interval ← Miscellaneous
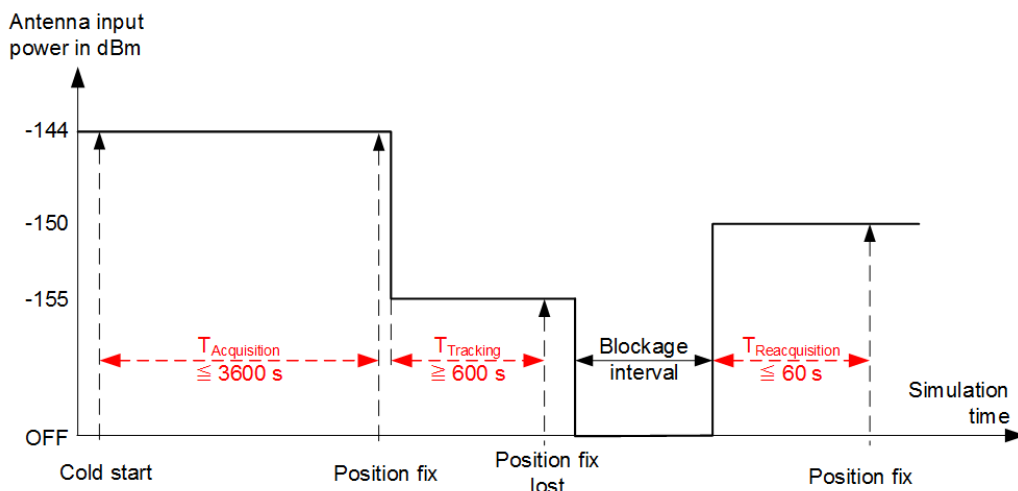
Specifies initial interval for signal on duration and blockage interval for signal off duration for TC 6.

TC 7 Blockage Interval ← Miscellaneous

Specifies blockage interval for signal off duration for TC 7.

Set to Default ← Miscellaneous
Resets all settings in the dialog to the values required by the test specification.

1.5 Test Results

The measurement report contains results in line with the selected test specification, 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. In addition, the measurement report indicates all the parameters set to non-default values.

eCall: Test Case 1 - Verify NMEA transmission from DUT

Test Items and Conditions	DUT	Threshold	Result	Unit	Status
NMEA-0183 Sentence rate 1Hz *GPS/Galileo/SBAS*	ublox EVK-M8N	500	127	ms	
NMEA-0183 Format: GGA *GPS/Galileo/SBAS*	ublox EVK-M8N		OK		
NMEA-0183 Format: GSA *GPS/Galileo/SBAS*	ublox EVK-M8N		OK		
NMEA-0183 Format: GSV *GPS/Galileo/SBAS*	ublox EVK-M8N		OK		
NMEA-0183 Format: RMC *GPS/Galileo/SBAS*	ublox EVK-M8N		OK		
NMEA-0183 Format: VTG *GPS/Galileo/SBAS*	ublox EVK-M8N		OK		
NMEA-0183 Sentence rate 1Hz *Galileo*	ublox EVK-M8N	500	126	ms	
NMEA-0183 Format: GGA *Galileo*	ublox EVK-M8N		OK		
NMEA-0183 Format: GSA *Galileo*	ublox EVK-M8N		OK		
NMEA-0183 Format: GSV *Galileo*	ublox EVK-M8N		OK		
NMEA-0183 Format: RMC *Galileo*	ublox EVK-M8N		OK		
NMEA-0183 Format: VTG *Galileo*	ublox EVK-M8N		OK		
NMEA-0183 Sentence rate 1Hz *GPS*	ublox EVK-M8N	500	124	ms	
NMEA-0183 Format: GGA *GPS*	ublox EVK-M8N		OK		
NMEA-0183 Format: GSA *GPS*	ublox EVK-M8N		OK		
NMEA-0183 Format: GSV *GPS*	ublox EVK-M8N		OK		
NMEA-0183 Format: RMC *GPS*	ublox EVK-M8N		OK		
NMEA-0183 Format: VTG *GPS*	ublox EVK-M8N		OK		
Test result					Passed

eCall: Test Case 2 - Location accuracy (static receiver)

Test Items and Conditions	DUT	Threshold	Result	Unit	Status
Planimetric error *GPS/Galileo/SBAS*	ublox EVK-M8N	15	0.48	m	
Planimetric error *Galileo*	ublox EVK-M8N	15	2.5	m	
Planimetric error *GPS*	ublox EVK-M8N	15	2.81	m	
Test result					Passed

eCall: Test Case 3 - Location accuracy (moving receiver) open sky

Test Items and Conditions	DUT	Threshold	Result	Unit	Status
Planimetric error GPS/Galileo/SBAS	ublox EVK-M8N	15	1.07	m	
Planimetric error Galileo	ublox EVK-M8N	15	3.16	m	
Planimetric error GPS	ublox EVK-M8N	15	10.97	m	
Test result					Passed

eCall: Test Case 4 - Location accuracy (moving receiver) intermitted reception and urban canyon

Test Items and Conditions	DUT	Threshold	Result	Unit	Status
Planimetric error GPS/Galileo/GLONASS/SBAS	ublox EVK-M8N	40	3.07	m	
Linear error GPS/Galileo/GLONASS/SBAS	ublox EVK-M8N	min. 95	100	%	
Planimetric error Galileo	ublox EVK-M8N	40	6.65	m	
Linear error Galileo	ublox EVK-M8N	min. 95	100	%	
Planimetric error GPS	ublox EVK-M8N	40	17.31	m	
Linear error GPS	ublox EVK-M8N	min. 95	100	%	
Test result					Passed

eCall: Test Case 5 - Time-to-first fix (TTFF) under cold start conditions

Test Items and Conditions	DUT	Threshold	Result	Unit	Status
-130 dBm: Average Position fix time in cold start mode: GPS/Galileo	ublox EVK-M8N	60	21.12	s	
-140 dBm: Average Position fix time in cold start mode: GPS/Galileo	ublox EVK-M8N	300	21.12	s	
-130 dBm: Average Position fix time in cold start mode: Galileo	ublox EVK-M8N	60	53.79	s	
-140 dBm: Average Position fix time in cold start mode: Galileo	ublox EVK-M8N	300	103.89	s	
-130 dBm: Average Position fix time in cold start mode: GPS	ublox EVK-M8N	60	21.09	s	
-140 dBm: Average Position fix time in cold start mode: GPS	ublox EVK-M8N	300	21.1	s	
Test result					Passed

eCall: Test Case 6 - Reacquisition time

Test Items and Conditions	DUT	Threshold	Result	Unit	Status
-130 dBm: Average reacquisition time: GPS/Galileo	ublox EVK-M8N	20	1.07	s	
-130 dBm: Average reacquisition time: Galileo	ublox EVK-M8N	20	1.05	s	
-130 dBm: Average reacquisition time: GPS	ublox EVK-M8N	20	1.06	s	
Test result					Passed

eCall: Test Case 7 - Tracking and acquisition sensitivity

Test Items and Conditions	DUT	Threshold	Result	Unit	Status
-144 dBm Acquisition mode sensitivity: GPS/Galileo	ublox EVK-M8N	3600	34.48	s	
-155 dBm Tracking mode sensitivity: GPS/Galileo	ublox EVK-M8N	min. 600	600.03	s	
-150 dBm Reacquisition mode sensitivity: GPS/Galileo	ublox EVK-M8N	60	1.19	s	
Test result					Passed

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

Annex: Errors and Warnings

Message	Test	Testcase			
Errors and Warnings					
[TC::NMEA] GPGSV,3,1,12,01,88,360,46,03,60,259,46,08,22,181,46,11,67,167,46,0 has format problem: Satellite with ID 01 is used in GSA sentence for position calculation but "Azimuth, degrees True, 000 to 359" is '360' which is not valid in GSV sentence	eCall	Testcase2			Warning
[TC::NMEA] GAGSV,3,3,10,23,87,360,45,29,10,073,45,0 has format problem: Satellite with ID 23 is used in GSA sentence for position calculation but "Azimuth, degrees True, 000 to 359" is '360' which is not valid in GSV sentence	eCall	Testcase3			Warning

1.6 Test Module Details

The tests configure and control the simulated GNSS.

For each test case, the test automatically configures and controls the IVS, as required for the test case.

The test executes all test cases listed with an enabled checkbox.