R&S®EMC32 EUT Monitoring with R&S® Digital Oscilloscopes

Application Note

Products:

- R&S®RTO
- R&S®RTE
- R&S®RTM
- R&S®EMC32

This application note describes how to use the mask and limit test features of the R&S®RTO, R&S®RTE and R&S®RTM Digital Oscilloscopes for EUT monitoring of signal forms, jitter etc. with the R&S®EMC32 Measurement Software. The mask test function allows autonomous characterization of digital signal integrity during EMS tests.
R&S®EMC32 software records violations of user-defined limits or mask templates and evaluates the immunity threshold at frequencies of critical electromagnetic susceptibility.

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1 Overview

This application note describes how to use the mask and limit test features of the R&S®RTO, R&S®RTE and R&S®RTM Digital Oscilloscopes for EUT monitoring with the R&S®EMC32 EMS Measurement Software. A mask test monitors the integrity of digital signals while a limit test monitors a calculated value such as amplitudes (dB, A, V, etc.), rise times, jitter, etc. As soon as a user-defined mask or limit is violated, R&S®EMC32 records the violation and evaluates the immunity threshold at the current frequency.

The following abbreviations are used in the following text for R&S® test equipment:

- The R&S®EMC32 EMS Measurement Software for Conducted and Radiated Susceptibility is referred to as EMC32. The R&S®EMC32-S Software for immunity basic measurements is referred to as EMC32-S.
- The R&S®RTE1022, R&S®RTE1024, R&S®RTE1032, R&S®RTE1034, R&S®RTE1052, R&S®RTE1054, R&S®RTE1102, R&S®RTE1104 Digital Oscilloscopes are referred to as RTE.
- The R&S®RTO1002, R&S®RTO1004, R&S®RTO1012, R&S®RTO1014, R&S®RTO1022, R&S®RTO1024, R&S®RTO1044 Digital Oscilloscopes are referred to as RTO.
- The R&S®RTM2032, R&S®RTM2034, R&S®RTM2052, R&S®RTM2054 Digital Oscilloscopes are referred to as RTM.
- Digital Oscilloscopes RTO, RTE and RTM are referred to as RTx.
- The R&S®SMB100A Signal Generator is referred to as SMB.
- The R&S®BBA100 Power Amplifier is referred to as BBA100.
- R&S® stands for Rohde & Schwarz GmbH & Co KG.

2 Hardware Configuration

Fig. 2-1 shows a typical conducted EMS test environment, consisting of an oscilloscope (RTO, RTE or RTM), connected via a LAN interface to a PC that runs EMC32-S software, an SMB signal generator and a BBA100 power amplifier according to IEC/EN 61000-4-6 to monitor a defined EUT test point with the RTO / RTE / RTM mask or RTO / RTE limit test feature.

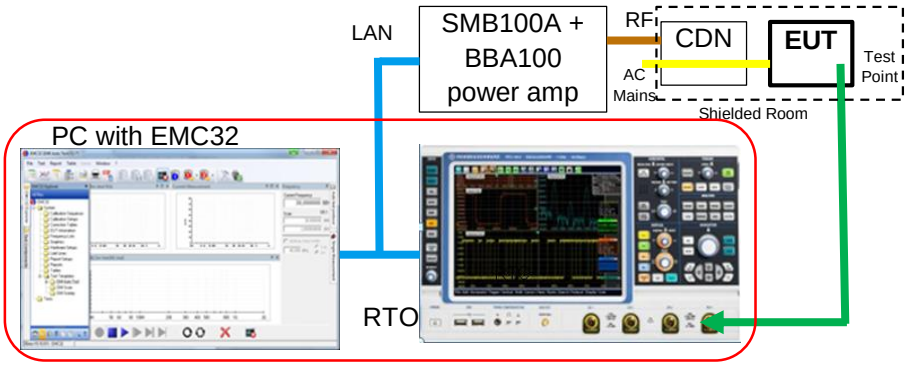


Fig. 2-1: Typical CDN setup for conducted EMS measurements according to IEC/EN 61000-4-6

The **RTE / RTO** requires firmware **v2.30.1.0** or higher, the **RTM v05.400** or higher.

3 RTx Mask Test Functionality for EUT Monitoring

The mask test feature of the RTO, RTE and RTM oscilloscopes allows to define a “masked” area around a signal (including uncertainties) taken from a relevant test point on the EUT.

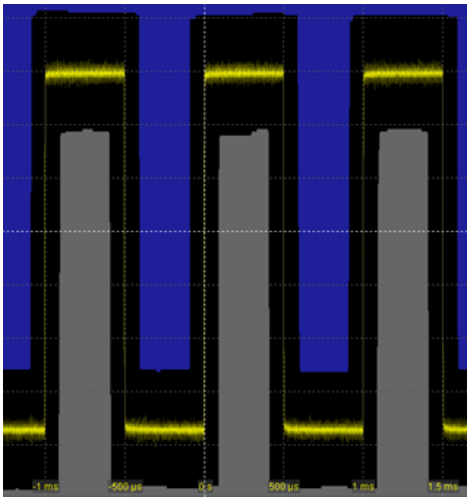


Fig. 3-1: Pulsed signal with masked area

During an EMS measurement the EUT is exposed to conducted and radiated interferers, which may have an effect on the signal at the test point. These measurements are usually unattended and therefore require automatic monitoring. The RTO / RTE / RTM mask test will notify the EMC32 software immediately in case the signal violated the mask and will also transmit the current interferer frequency.

3.1 RTO / RTE Oscilloscope Settings

A mask can be created by selecting the **MASKS** button on the front panel of the RTO or RTE and setting the parameters in the dialog boxes **TEST DEFINITION**, **MASK DEFINITION**, **EVEN ACTION / RESET**, **MASK DISPLAY**.

3.1.1 Test Definition

The following parameters shall be used:

Enable test: Enable / disable the mask test by clicking on this soft-key.

Definition type: If **WAVEFORM** is selected, a mask is created from an existing waveform. A given offset from the waveform builds the upper and lower limit lines of the mask, limits that can be moved and stretched. The result is a tolerance tube around the waveform used as mask.

Fail condition, Violation tolerance: The fail criteria for a mask test are set by two parameters: "Fail condition" and "Violation tolerance".

"**Fail condition**" defines the kind of hits to be considered for test evaluation:

- **SAMPLES**: Number of samples (**VIOLATION TOLERANCE**) that hit the mask.
- **ACQUISITIONS**: Number of acquisitions (**VIOLATION TOLERANCE**) that contain at least one sample hitting the mask.

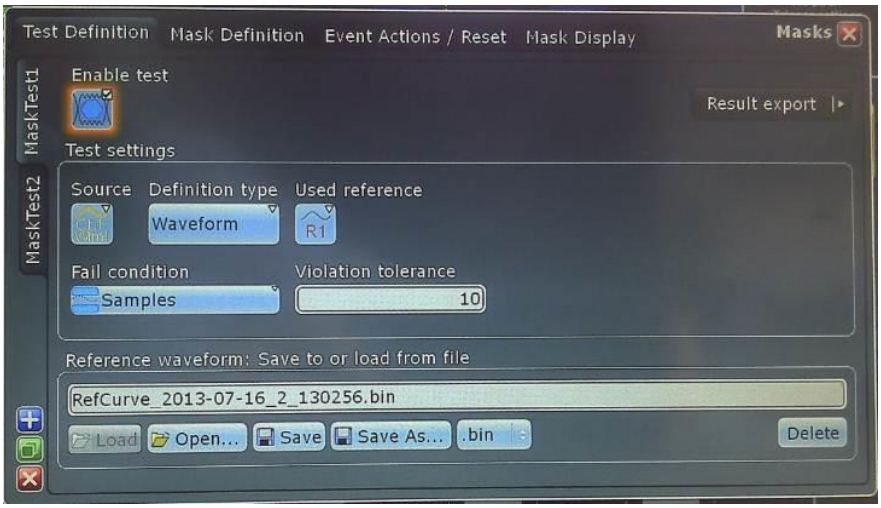


Fig. 3-2: RTO "Test Definition" Tab

3.1.2 Mask Definition

DEFINITION TYPE: Select **WAVEFORM** to create a mask from an existing waveform.

HORIZONTAL WIDTH: Sets the mask width (div).

VERTICAL WIDTH: Sets the mask height (div).

CREATE MASK: Creates the upper and lower mask limit from the selected reference waveform. If the reference waveform was not defined before, it is created automatically from the **SOURCE** waveform, which is selected in the **TEST DEFINITION** tab.

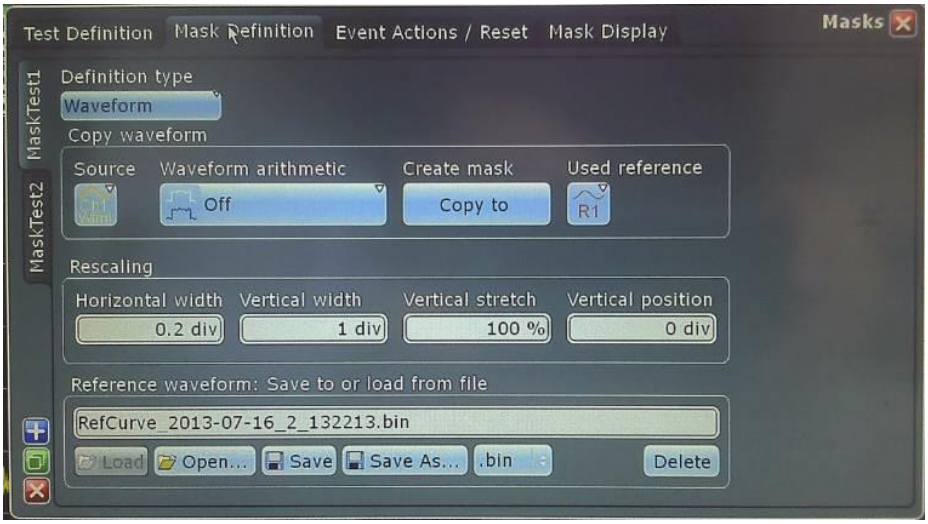


Fig. 3-3: RTO "Mask Definition" Tab

3.1.3 Event Actions / Reset

This tab defines, which actions shall be taken in case the mask was violated or not. Most actions can be initiated either on violation or pass:

ON VIOLATION: The parameter **STOP ACQ** is set to **ON VIOLATION** in the **EVENT ACTIONS / RESET** tab. This action will be initiated (thus, the acquisition of samples will be stopped) as soon as the signal violates the mask and the fail criteria are fulfilled.

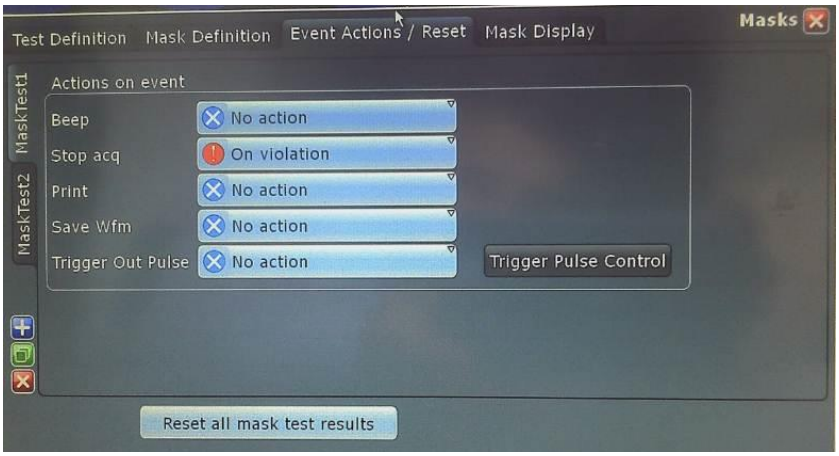


Fig. 3-4: RTO / RTE "Event Actions / Reset" Tab

3.1.4 Mask Display

The **MASK DISPLAY** tab contains all settings for mask and hit display. Different colors can be assigned to the actions for better readability.

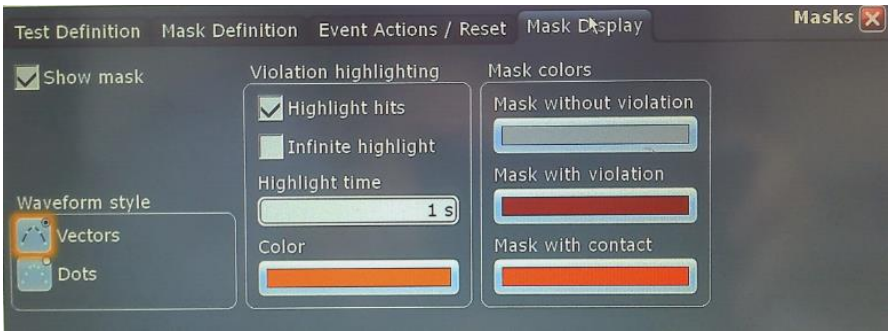


Fig. 3-5: RTO / RTE "Mask Display" Tab

3.1.5 Test Examples

The following example shows a signal that does not violate the mask.

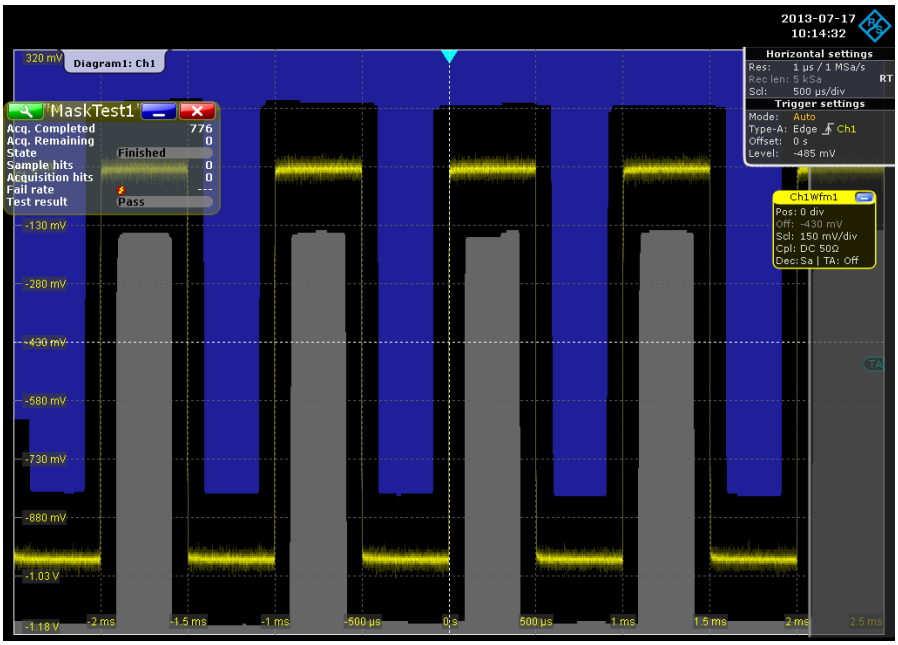


Fig. 3-6: Test Example without mask violation

Fail Criteria "Samples":
This test has failed because 10 or more samples have violated the mask.

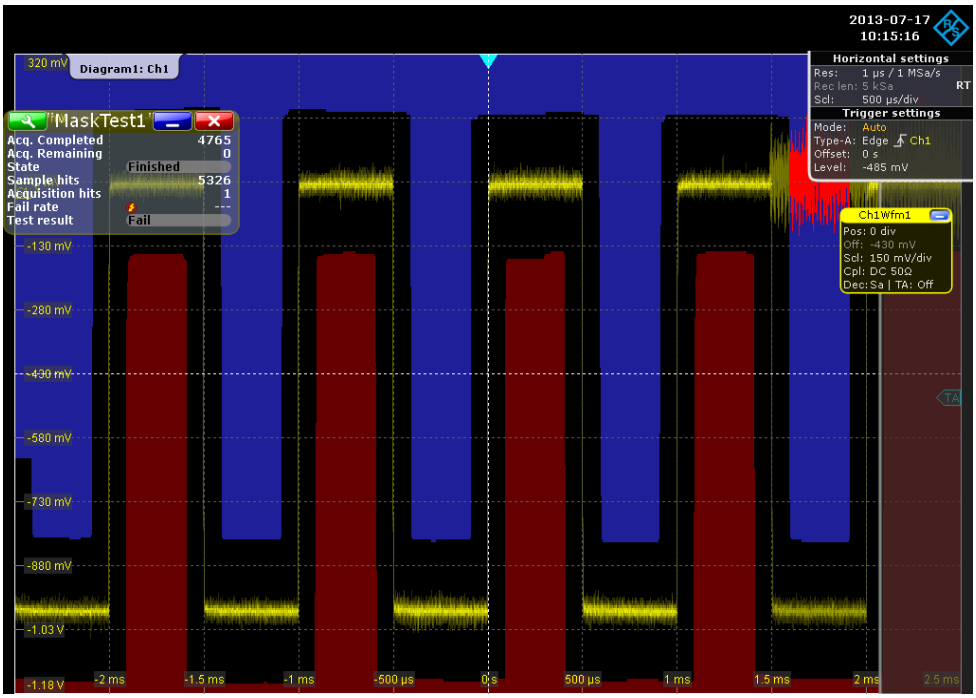


Fig. 3-7: Test example with fail criteria "Samples"

Fail Criteria "Acquisition":
This example test failed because the 7th acquisition violated the mask with at least one sample.

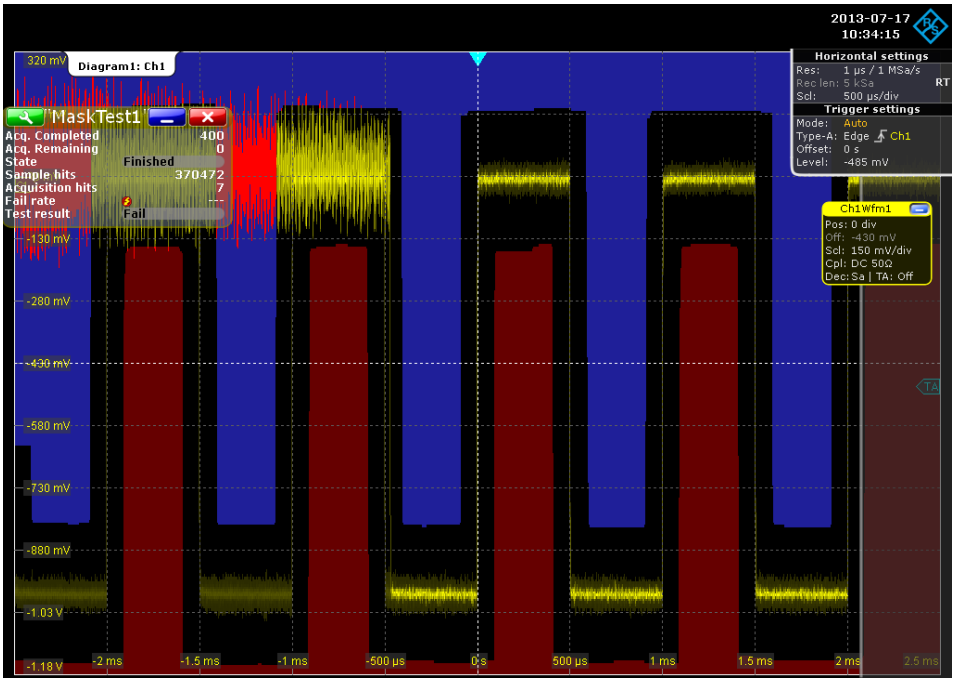


Fig. 3-8: Test example with fail criteria "Acquisition"

3.2 RTM Oscilloscope Settings

A mask can be created by selecting the **TOOLS** button, then the **MASK TEST** soft key.

3.2.1 Test Definition

The following parameters shall be used:

Test – Enable / disable the mask test by clicking on this soft-key.

New Mask → **COPY CHANNEL** – Generates a mask surrounding the original waveform. Use Y-Position, Stretch Y, Width Y and Width X to define a custom mask area. Press Save to store the custom mask.

Fig. 3-9: RTM New Mask

ACTIONS – Defines which events will be initiated in case the mask is violated:

- **SOUND** – Alarm can be turned OFF, go off after each violation or after n mask violations.
- **STOP** – Mask test can continue or be stopped after one or n mask violations.
- **SCREENSHOT** – No screenshot, or one screenshot after each or n mask violations.
- **PRINT** – Print waveform data after each or n violations.
- **WAVEFORM** – Save waveform after each or n violations.
- **PULSE** – Turn ON custom pulse at trigger output after each or n violations.

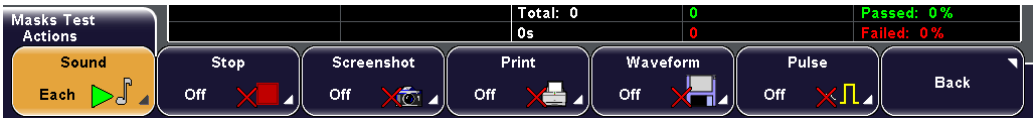


Fig. 3-10: RTM Mask Test Actions

The figure below shows an example mask test of a pulse curve.

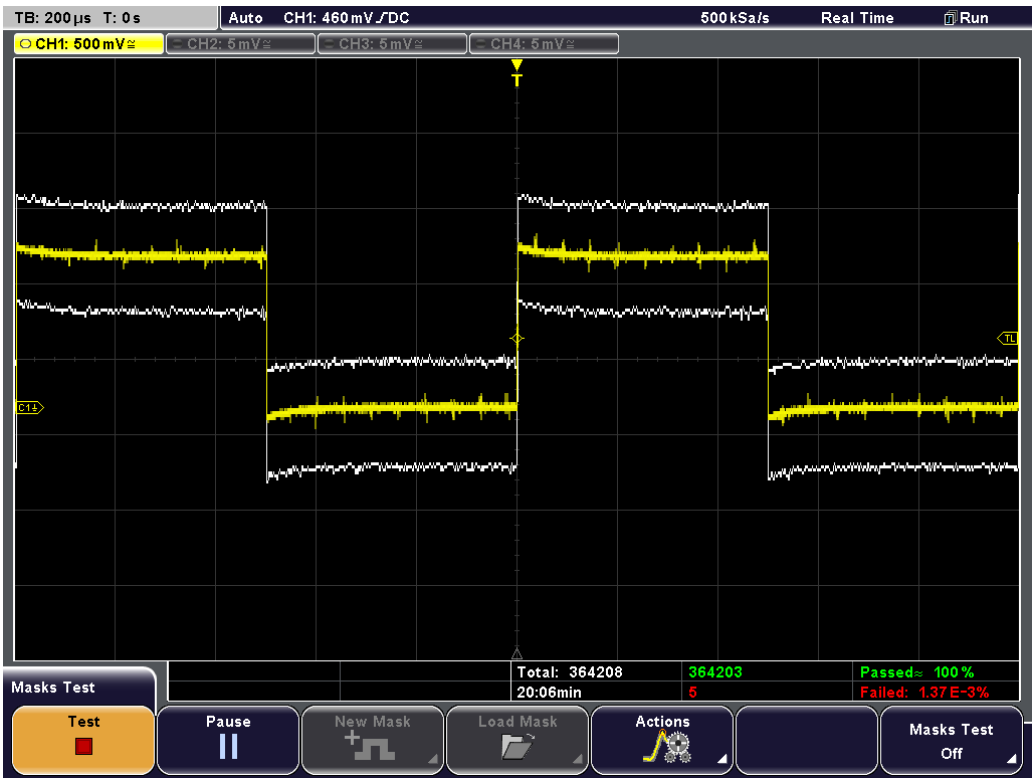


Fig. 3-11: Mask Test running on RTM Oscilloscope

3.3 Device Setting in EMC32

3.3.1 Adding the Device to the Device List

The configuration is done in the Device List, which is accessible via the menu **EXTRAS –> DEVICE LIST …**

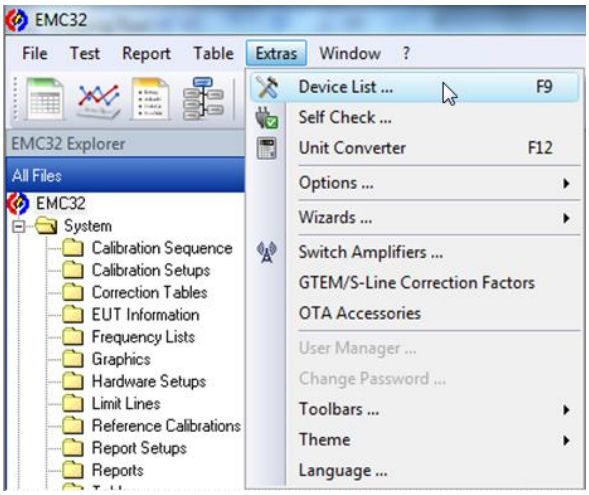


Fig. 3-12: Opening the Device List

or with the function key shortcut “F9”

or via the Device List icon 

Add the **GENERIC MONITORING** device to the right side of the **DEVICE LIST** as **CONFIGURED DEVICE**.

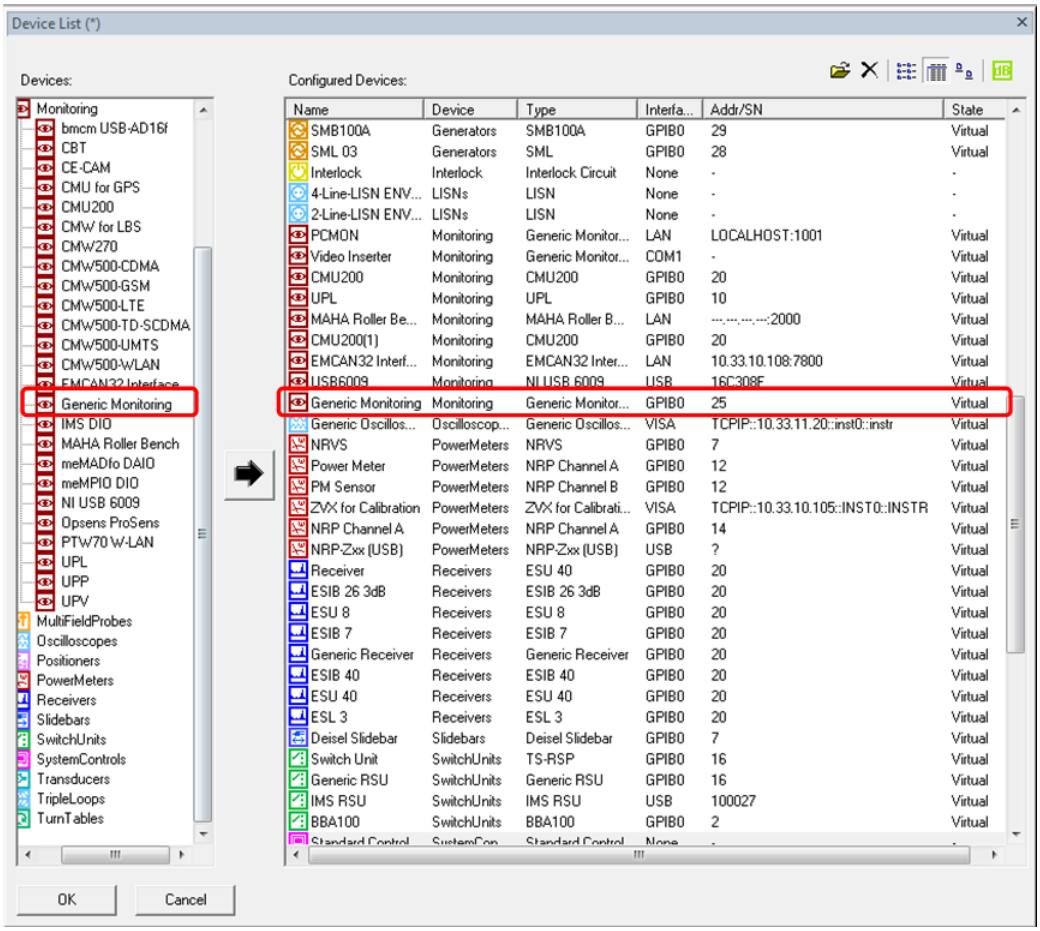


Fig. 3-13: "Generic Monitoring" device added to "Configured Devices"

Single click on the entry and rename **GENERIC MONITORING** to an appropriate Device Name, e.g. **RTO TEST MASK** (or RTE / RTM).

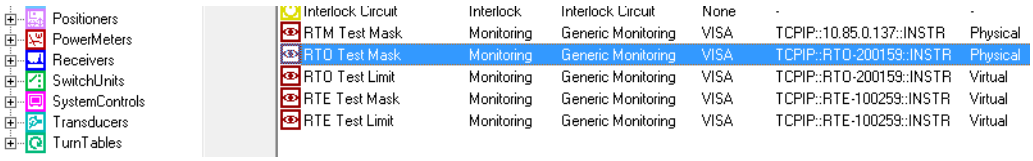


Fig. 3-14: Rename "Generic Monitoring" to "RTO Test Mask"

Note: Please make sure that all necessary instrument drivers, e.g. SMB, NRP-Zxx have been installed, before running an EMS test. If some or all devices are missing, a message box allowing simulation mode enabling will appear.

3.3.1.1 Generic Monitoring Properties

Edit the RTO / RTE / RTM Test Mask properties by double clicking on the menu item. It is defined by six properties:

- General
- Interface Parameters
- General Commands
- Device Programming
- Measurement Queries
- EMS Information

3.3.1.2 General and Interface Parameters Tabs

In the General tab, select the appropriate **INTERFACE TYPE** from a list of addresses or by using the **VISA DEVICE IDENTIFIER** (see Fig. 3-15).
After editing this parameter, close the RTO / RTE / RTM Mask Test window by pressing OK. Also close the Device List by pressing OK. If there have been significant changes in the Device List, a window pops up, advising to close and restart EMC32-S. Re-open the Device List and activate the **RTO TEST MASK** (or RTE / RTM) device by changing the **STATE** from **VIRTUAL** to **PHYSICAL**.

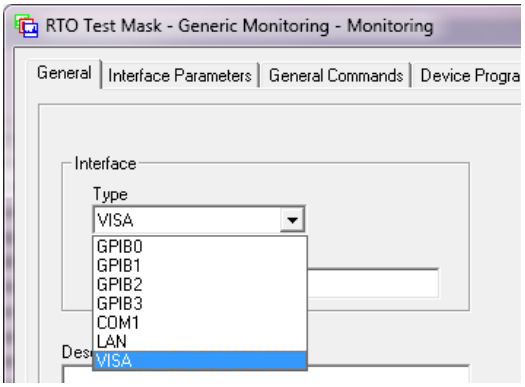


Fig. 3-15: Select Interface Type "VISA"

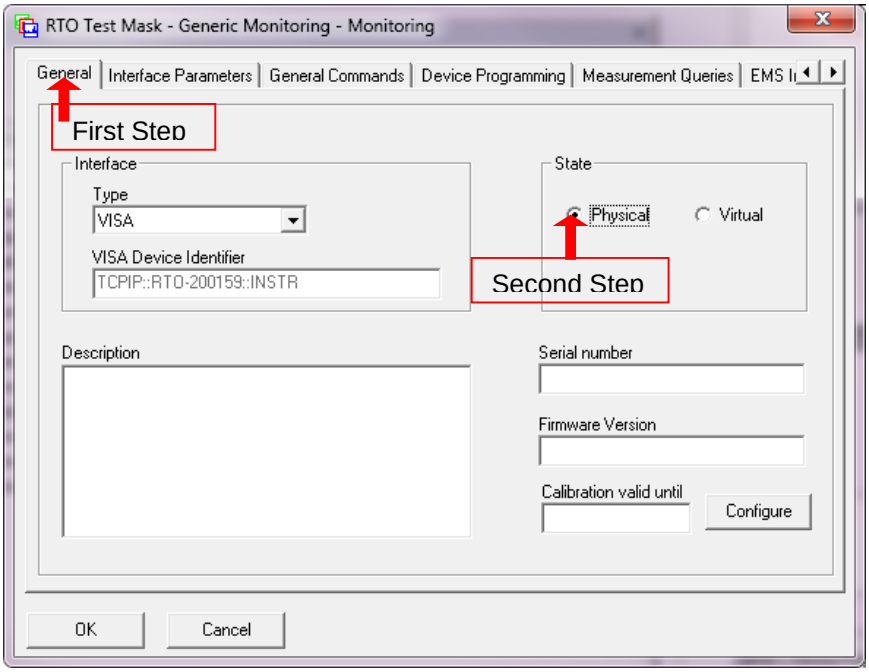


Fig. 3-16: Set State to "Physical"

Change to **INTERFACE PARAMETERS** tab and set the parameters.

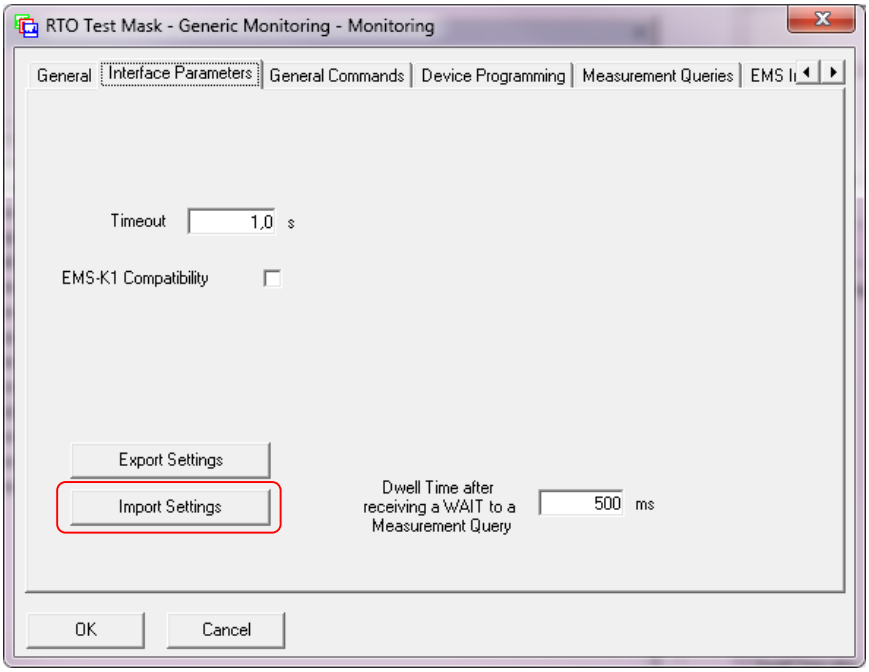


Fig. 3-17: Import settings

Import parameters by clicking **IMPORT SETTINGS**.

In the newly opened dialog box Import Settings, select predefined parameters by clicking the ... button, selecting **RTO / RTE / RTM MASK TEST** and pressing **OK**.

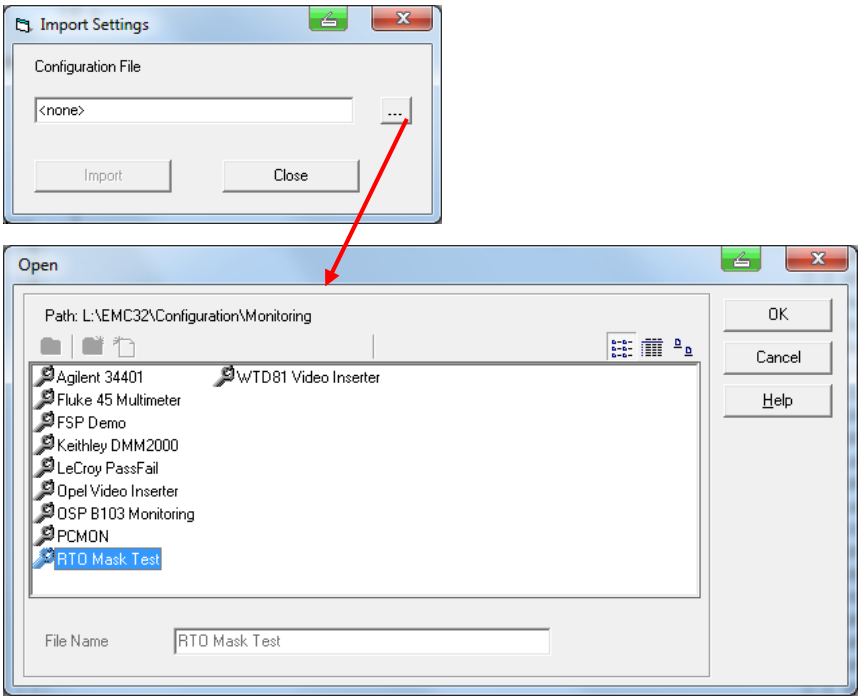


Fig. 3-18: Select "RTO Mask Test" configuration file, same for RTE/RTM

After pressing **OK**, the RTO / RTE / RTM Mask Test configuration file will be displayed in the **IMPORT SETTINGS** dialog.

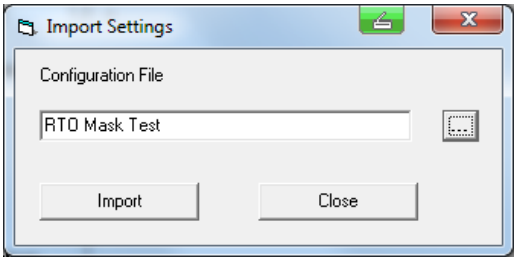


Fig. 3-19: Configuration File to Import

Click on **IMPORT** to load the configuration. The import is completed by pressing OK on the following message window.

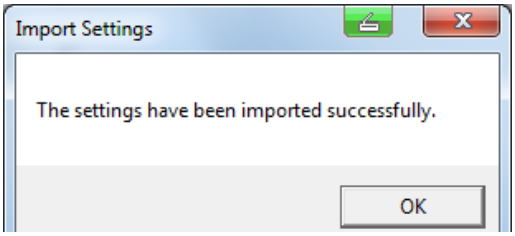


Fig. 3-20: Successful file import

The RTO / RTE / RTM Mask Test import file contains following lines.

3.3.1.3 General Commands

Commands for the basic configuration of the monitoring device are defined in this tab. The following commands are available:

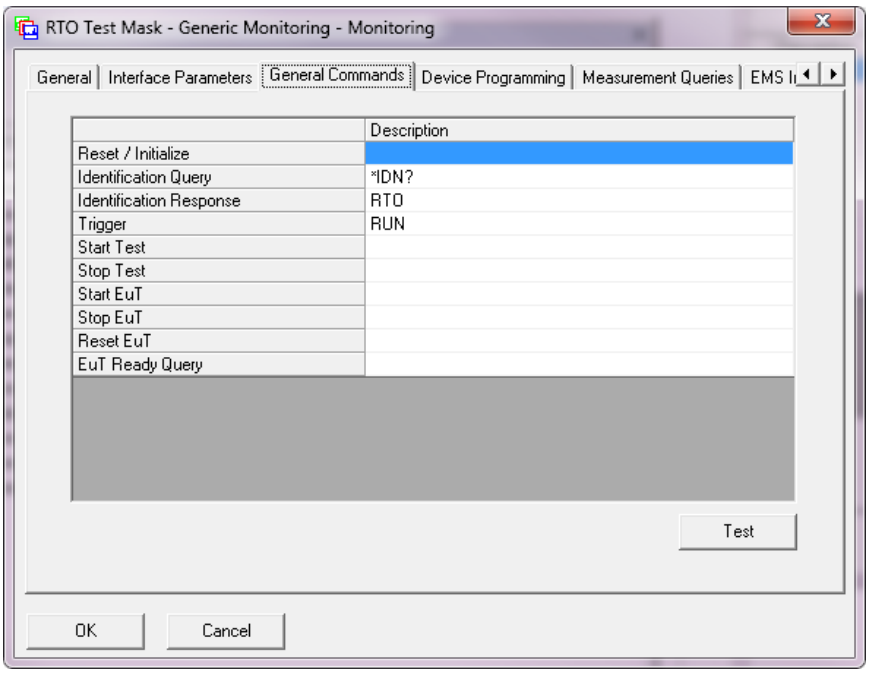


Fig. 3-21: Generic Monitoring Commands

3.3.1.4 Device Programming

This tab is not used in this context and therefore skipped here.

3.3.1.5 Measurement Queries

This tab contains the SCPI command for executing a Mask Test measurement and reading the result.

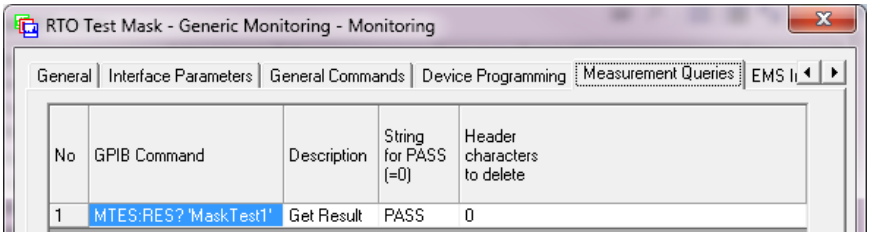


Fig. 3-22: "Measurement Queries" tab with Mask Test Result SCPI command

3.3.1.6 EMS Information

This tab is not used and therefore left empty. However, you have to press the 

button in this dialog window, to get to the **GENERIC MONITORING** test dialog.

3.3.1.7 Generic Monitoring Test Dialog

After pressing the Test button in the **EMS INFORMATION** tab, the following dialog box will be opened, allowing to select an item from the **GENERAL COMMANDS** or **MEASUREMENT QUERIES** list. Select **IDENTIFICATION QUERY** from the **GENERAL COMMANDS** and enter the **TEST COMMAND** "*IDN?". After pressing **TEST COMMAND**, the command is sent to the oscilloscope and the response (RTO / RTE / RTM ID string) is received. Then, exit this dialog by pressing **CLOSE**.

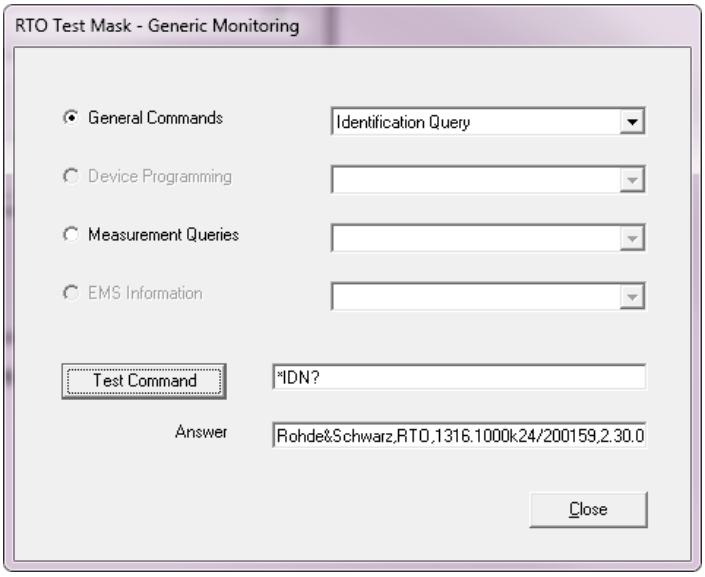


Fig. 3-23: Generic Monitoring Test Dialog

3.4 EUT Monitoring Example

In order to perform the example, a test template for EUT monitoring with an RTO / RTE / RTM oscilloscope is required first.

3.4.1 Oscilloscope Monitoring Settings

To generate a new EUT Monitoring Test Template, proceed as shown in Fig. 3-23.

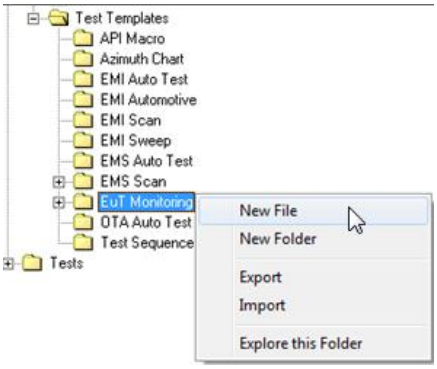


Fig. 3-24: EUT Monitoring Configuration: "New File"

In the EMC32 Explorer, select **FILE –> TEST TEMPLATE OPEN/NEW…**. Right-click on the **EUT MONITORING** menu item and select **NEW FILE**. A new window for configuring the **RTO TEST MASK** (or RTE / RTM) parameters pops up.

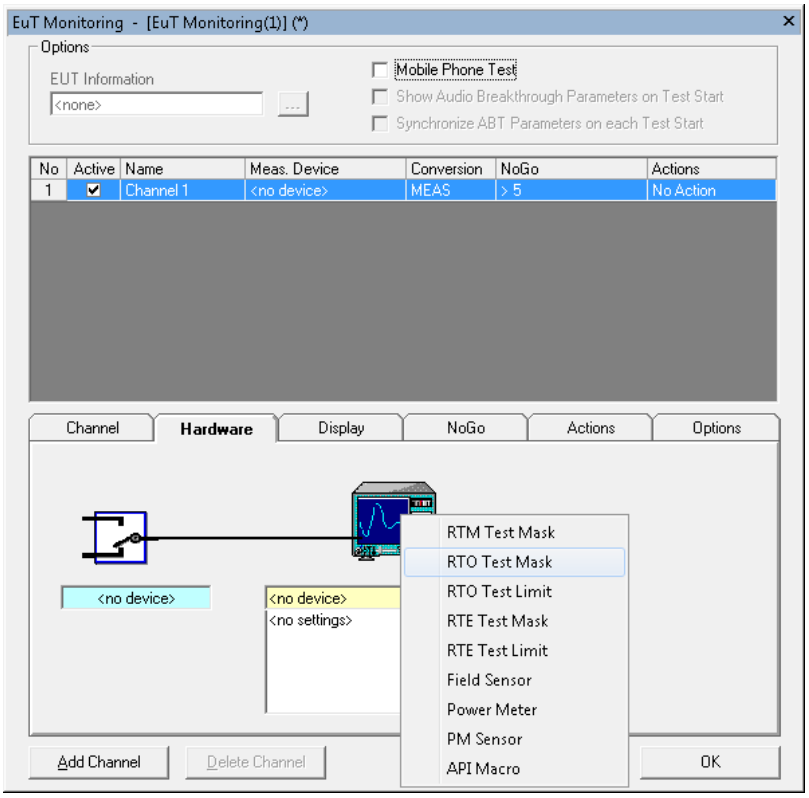


Fig. 3-25: EUT Monitoring configuration: RTx Test Mask selection

Right-click on the oscilloscope device icon in the **HARDWARE** tab and select **RTO TEST MASK** (or RTE / RTM) from the list.

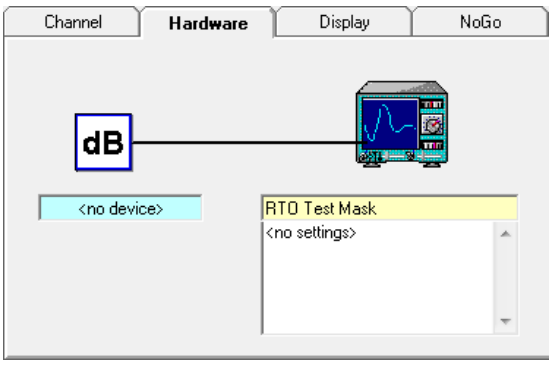


Fig. 3-26: EUT Monitoring Configuration: Selected Device

Then (left-) click on the icon to configure the device in the following pop-up window, according to Fig. 3-26: select “Send Trigger Command”, and specify the Measurement Query as “Get Result”.

.

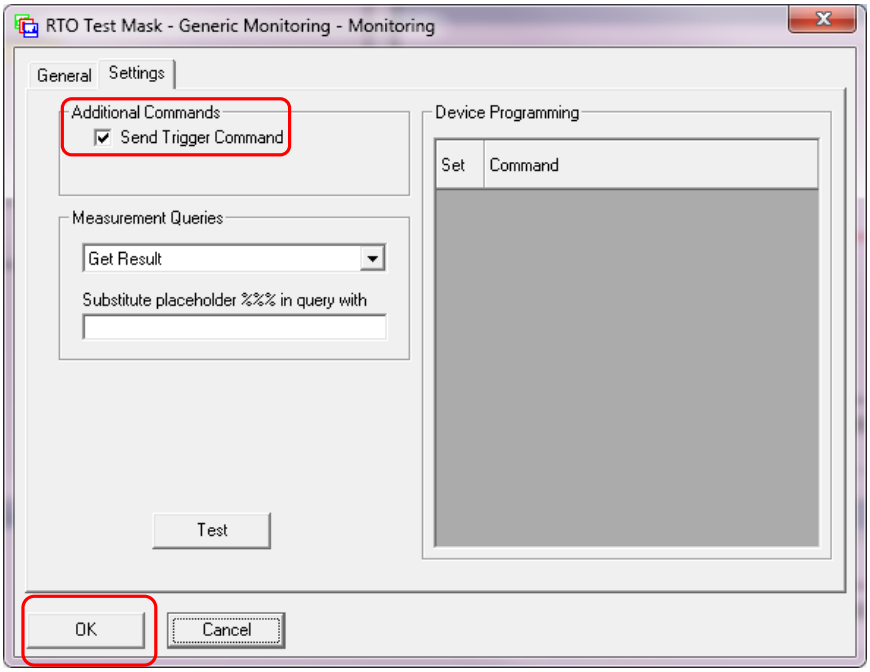


Fig. 3-27: EUT Monitoring Configuration: Device Settings

Press **OK** to complete the RTO / RTE / RTM Test Mask configuration, which appears in the EUT Monitoring configuration in Fig. 3-27.

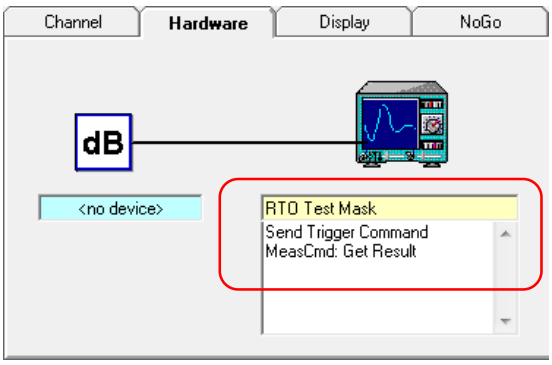


Fig. 3-28: EUT Monitoring Configuration

After configuring **RTO TEST MASK** (or RTE / RTM) go to the **CHANNEL** tab and select **TRIGGER MODE –> BEFORE DWELL**.

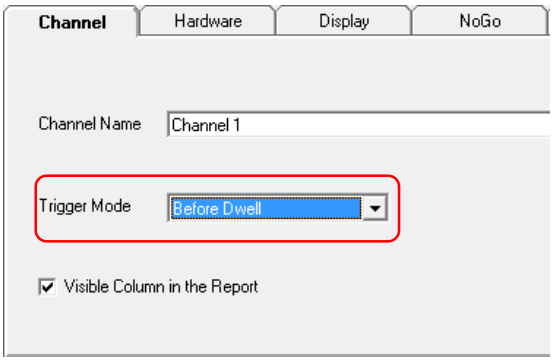


Fig. 3-29: EUT Monitoring Configuration: "Trigger Mode" Selection

In the **NOGO** tab, set **NOGO TYPE** to **ABOVE LIMIT**, set **LIMIT VALUE** = 0.50000 and press **OK** to save the **RTO MASK TEST** (or RTE / RTM) configuration.

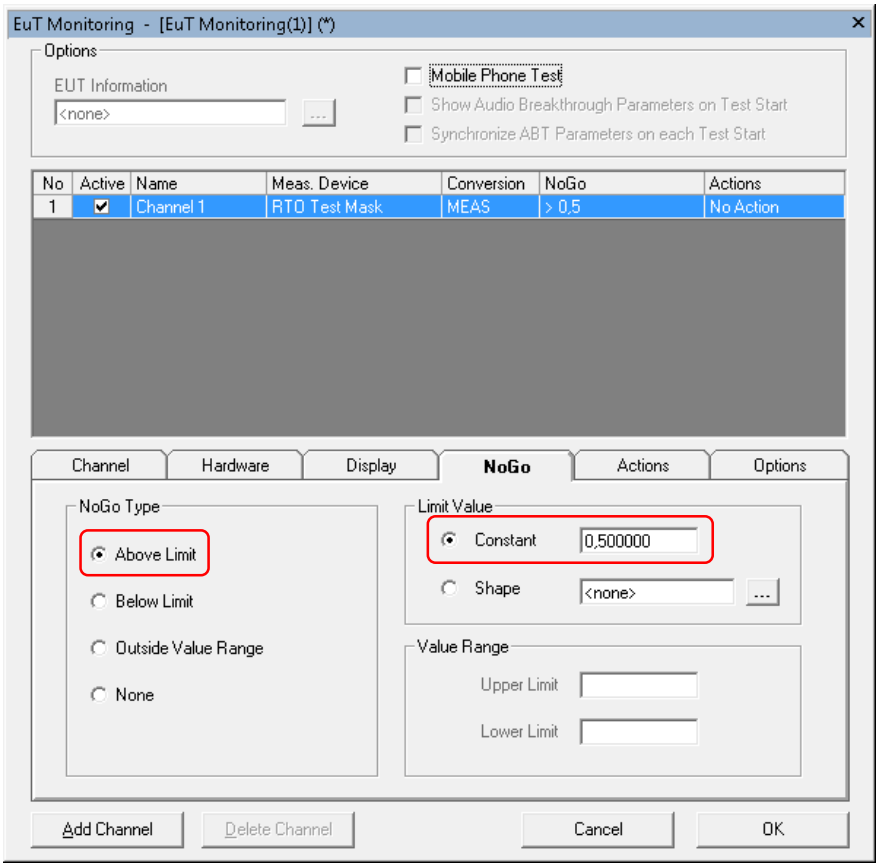


Fig. 3-30: EUT Monitoring Configuration: “Limit Value”

3.4.2 Actions

If the measurement should be stopped after a limit violation occurred, add **STOP TEST** to the **ACTION ON NOGO** item.

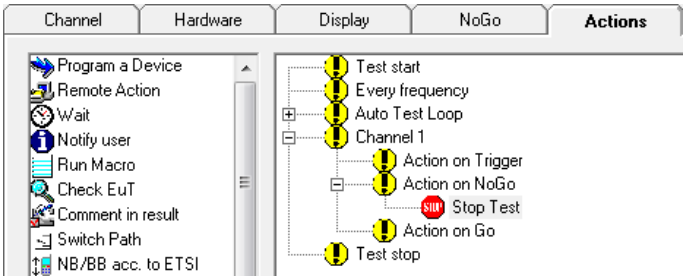


Fig. 3-31: Action on NoGo –> Stop Test

3.4.3 Start Test

Download DEVICECONFIGURATION_FILES.ZIP from the 1MA242 application note page and unzip **EUT TEST.EMSCONFIGURATION** to **<EMC32 DIRECTORY>\EMC32\SYSTEM\TEST TEMPLATES\EMS SCAN\EN61000-4-3**.and **RTO MASK TEST.EUTCONFIGURATION** , **RTE MASK TEST.*** and **RTM MASK TEST.*** to **<EMC32 DIRECTORY>\EMC32\SYSTEM\TEST TEMPLATES\EUT MONITORING**.

Note: In case of Windows7 and the default data directory **C:\PROGRAMDATA** it is necessary to make it visible first by unchecking the **HIDE PROTECTED OPERATING FILES** in the **FOLDER OPTIONS**.

In the EMC32 Explorer, right-click on the menu item **TEST TEMPLATE –> EMS SCAN –> EN61000-4-3** (EMS Radiated) **–> EUT TEST** and select **NEW TEST**.

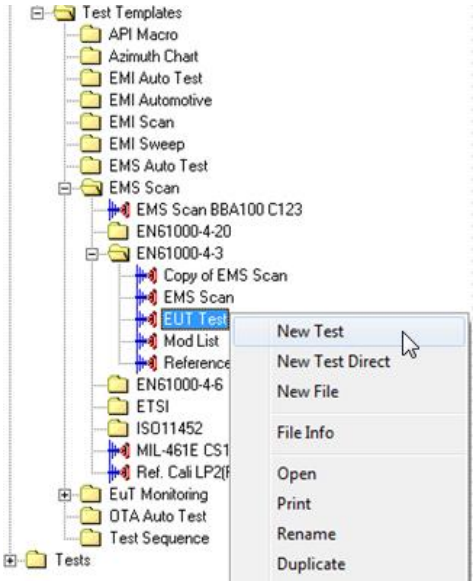


Fig. 3-32: Start EMS Scan Test Template as New Test

A **NEW TEST** window with EMS Radiated specific default parameters pops up.

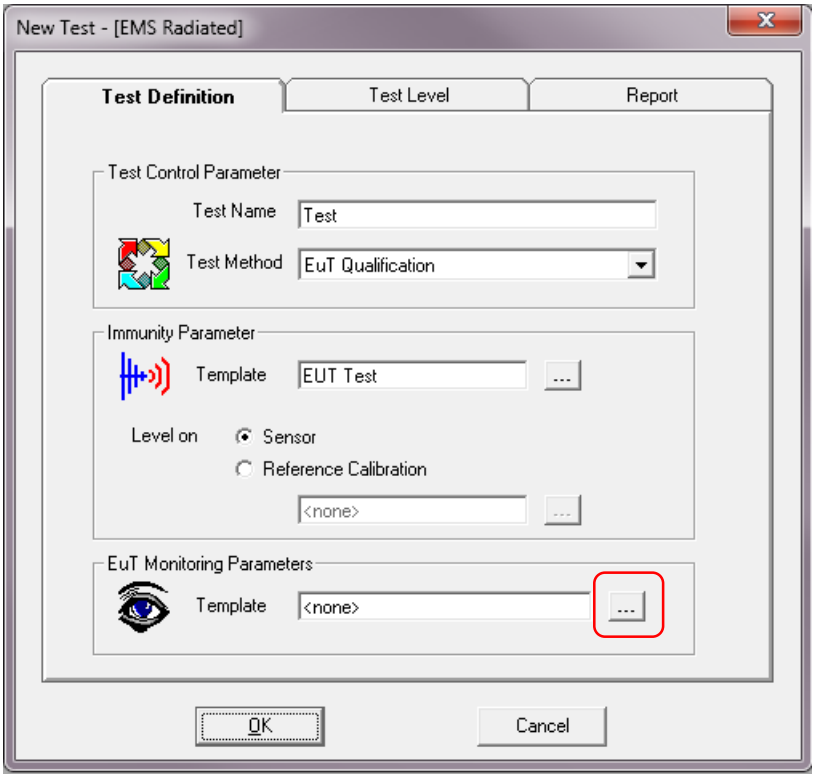


Fig. 3-33: New Test dialog

After pressing the **EUT MONITORING PARAMETERS –>**  icon, the EuT Monitoring Open window pops up, which allows to select **RTO MASK TEST** (or RTE / RTM).

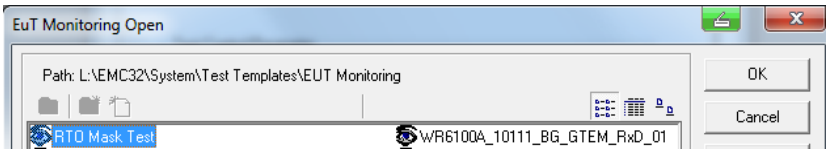


Fig. 3-34: EUT monitoring File location

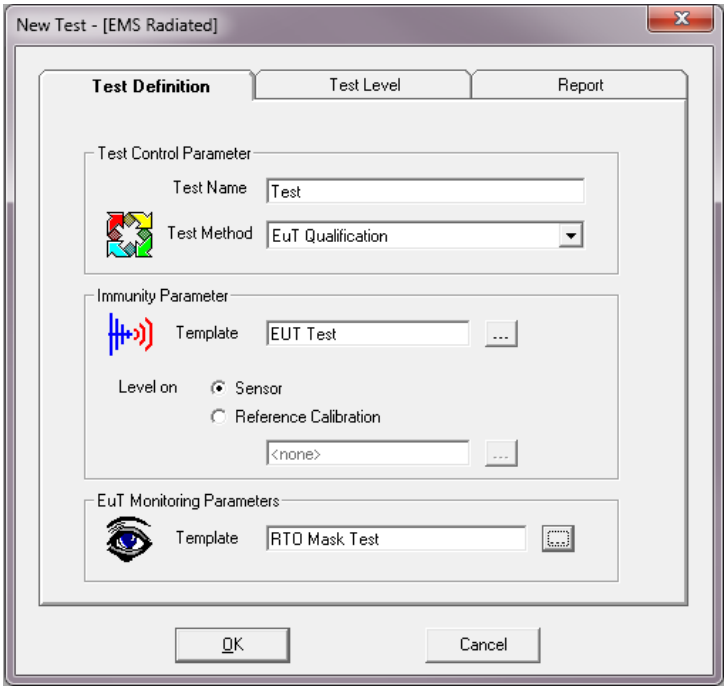


Fig. 3-35: New Test dialog with "RTO Mask Test"

After pressing **OK**, the test is ready for execution.

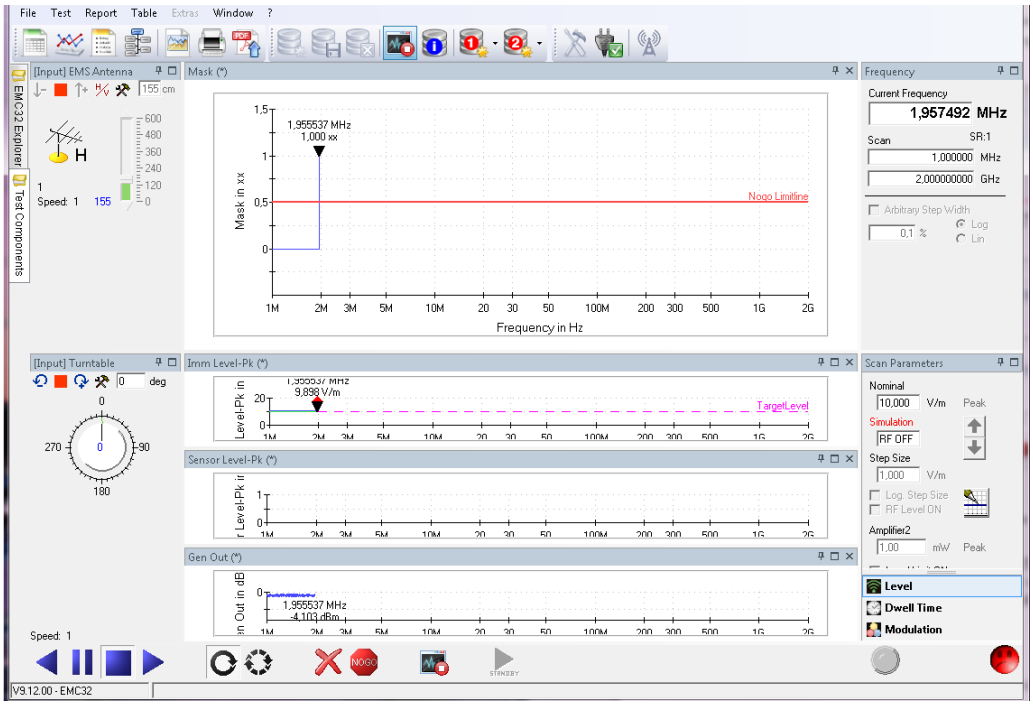


Fig. 3-36: EMC32 Test Execution

The upper graph in Fig. 3-35 (see also Fig. 3-36) shows how the Mask value jumps from 0 to 1 when the signal violates the test mask. With logical units (0 and 1) rather than a physical scale, any Mask value of 1 exceeds the pre-defined 0.5 limit line, thus rendering a **FAIL** result.

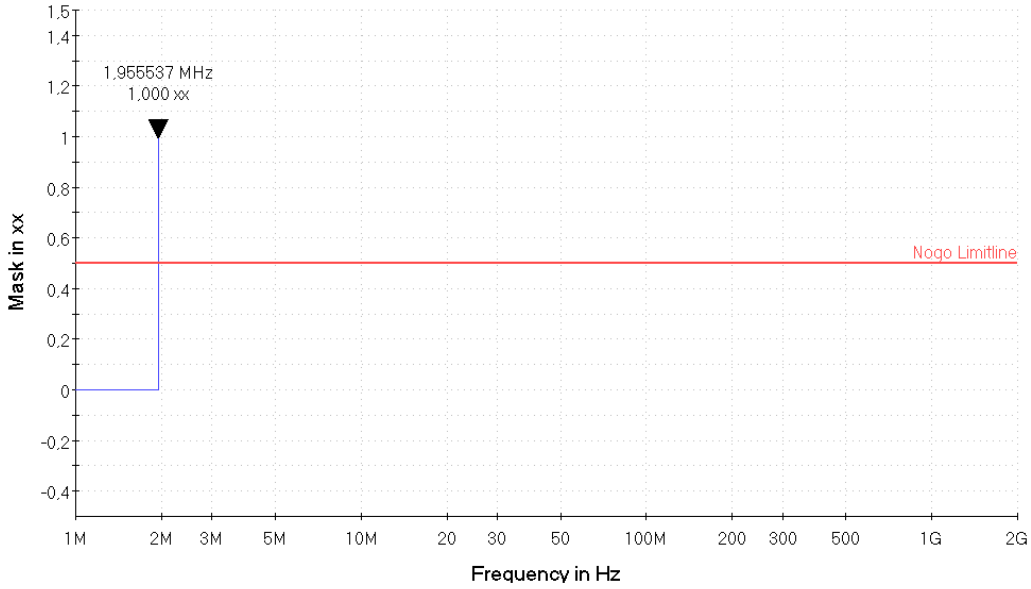


Fig. 3-37: EMC32 test execution

4 RTO / RTE Limit Test Functionality for EUT Monitoring

RTO / RTE oscilloscopes offer a wide range of measurement functions that are suitable for EUT monitoring tests. The measurement functions are divided in

- **AMP/TIME** – Amplitude, Peak to peak, Mean, RMS, etc.

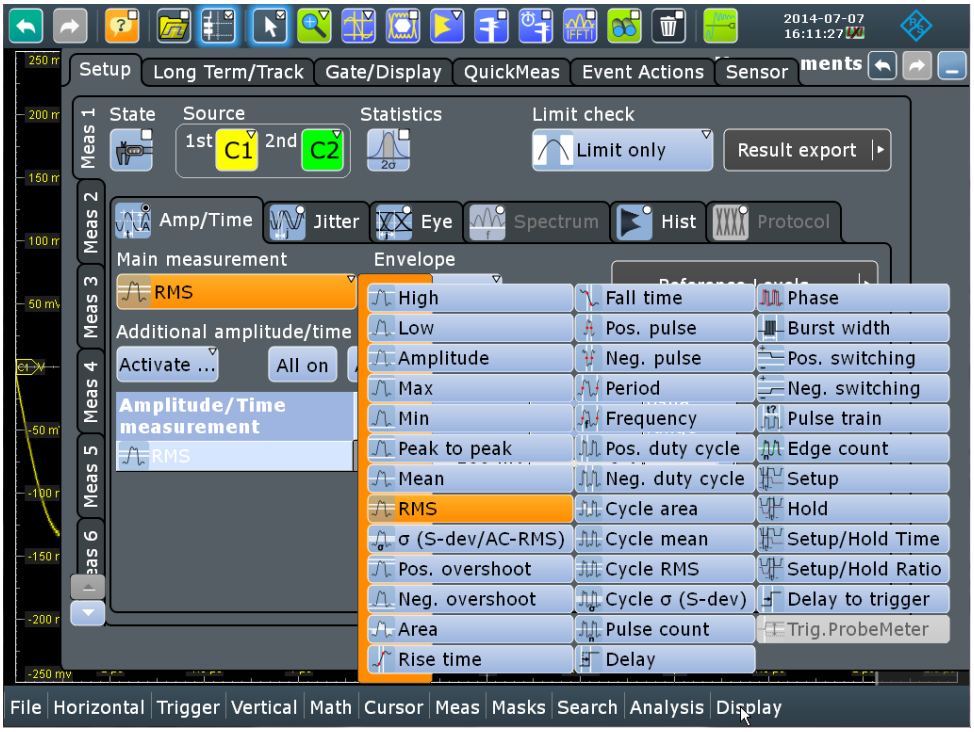
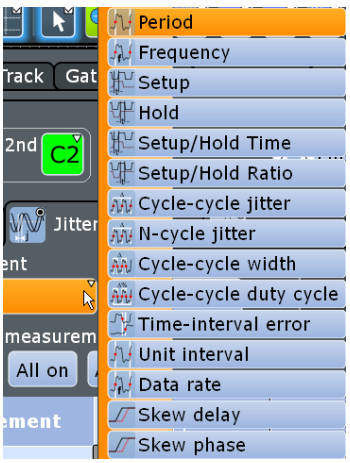
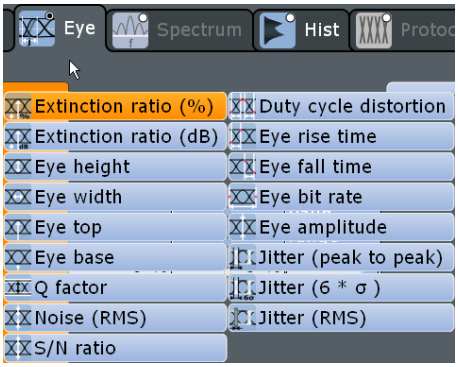


Fig. 4-1: RTO / RTE Amplitude and Time Measurement Functions

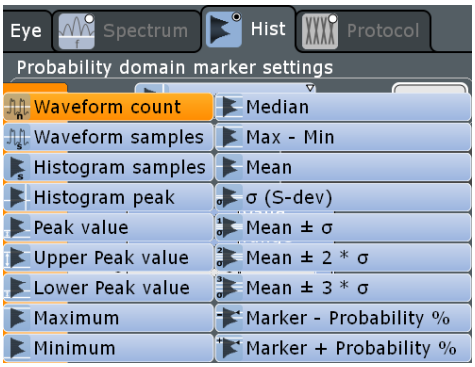
- **JITTER** – Period, Frequency, Cycle jitter, skew delay, etc.



- **EYE** – Extinction ratio (%), Q factor, Noise (RMS), S/N Ratio etc.



- **HISTOGRAM** – Histogram peak, Mean, Standard Deviation, etc.



Some measurement groups are only accessible with the according option (see RTO / RTE manual for more details on available options).

4.1 Amplitude Measurement

The first example will focus on an **amplitude** measurement, using the oscilloscope as a EUT monitoring device in EMC32.

A 100 kHz sine signal (-10 dBm) from any signal generator is fed into Channel 1 of the RTO / RTE.

4.1.1 Oscilloscope Settings

- Press **PRESET** on the RTO / RTE to obtain a defined initial state.
- Press **AUTOSET** for optimized display.

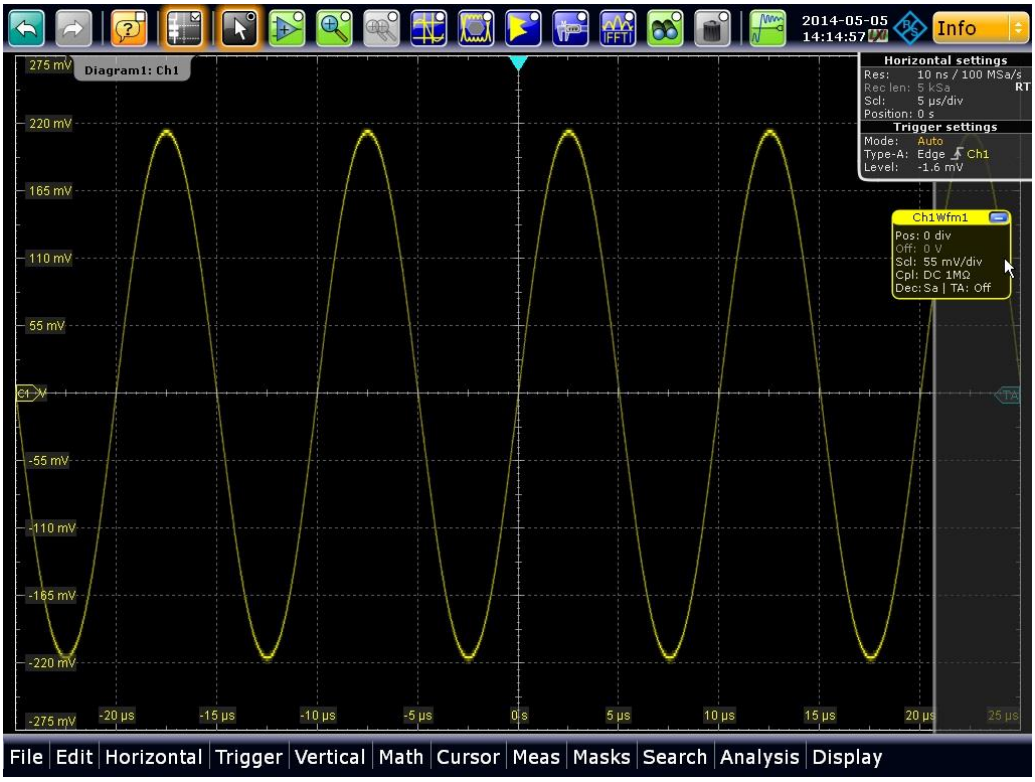


Fig. 4-1: The display shows an auto-triggered and auto-scaled measurement of amplitude over time

The peak-to-peak amplitude is approx. 440 mV.

- Select **MEAS –> SETUP** in the RTO / RTE menu.

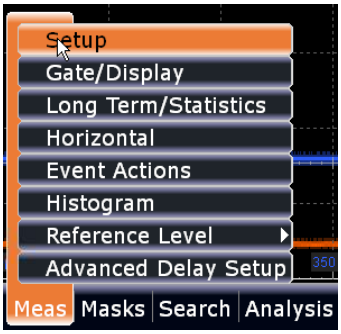


Fig. 4-2: Selecting the Setup dialog from the Measurement menu

- Activate **MEAS 1 STATE**
- Select the **AMP/TIME** tab
- Turn the Limit Check on by selecting **LIMIT ONLY**

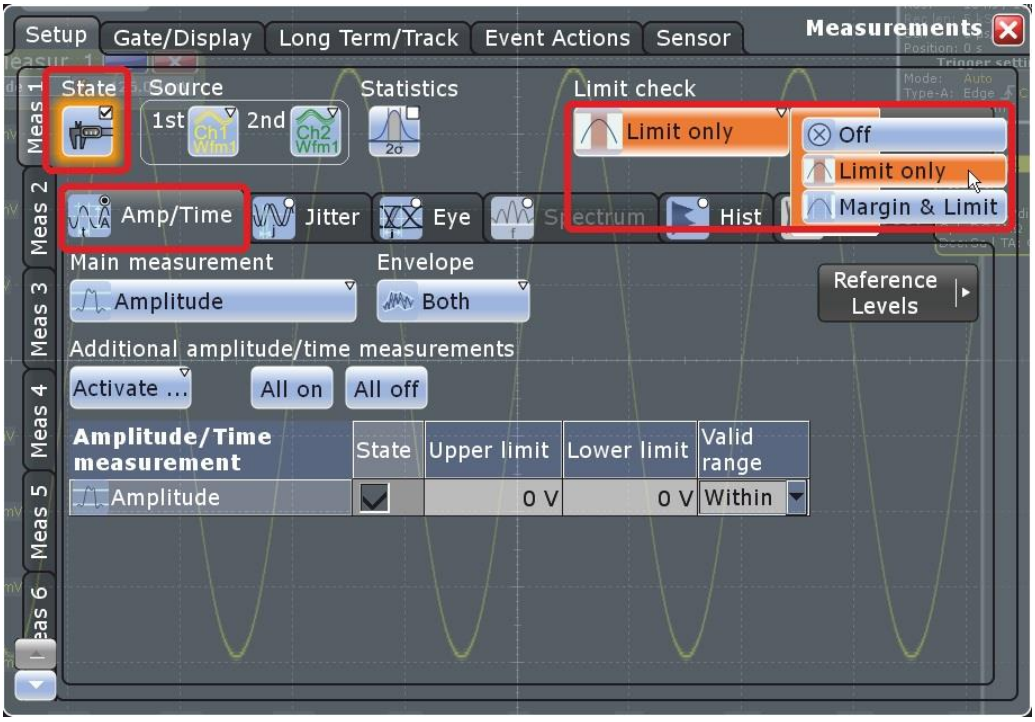


Fig. 4-3: Configuring the Setup dialog within the Measurement menu

- Close the **MEAS** dialog to read an actual amplitude measurement value.

Fig. 4-4: Here, the measured amplitude value is 426.09 mV

- Select **MEAS –> SETUP**, again
- Enter appropriate upper and lower limit values that come close to the measured value, e.g. 426.1 mV and 426.0 mV

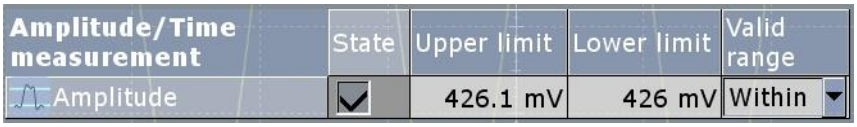


Fig. 4-5: Enter the upper and lower limit by double clicking on the values

If the amplitude exceeds the upper or lower limit, an alarm will be set. The amplitude measurement is now active.

To verify the measurement activity, the oscilloscope can be made to beep upon limit violation.

- Select **MEAS –> EVENT ACTIONS** in the RTO / RTE menu.

Fig. 4-6: Selecting the Event Actions dialog from the Measurement menu

Fig. 4-7: In the Event Actions dialog, select Beep -> On violation

To monitor the measurement, proceed with chapter 4.3 on EMC32 settings.

4.2 Jitter Measurement

The next example will focus on a measurement of **jitter** (periodicity deviations, or phase noise) and show how to define it in the RTO / RTE and as EUT monitoring device in EMC32.

Again, a 100 kHz sine signal (-10 dBm) is fed into Channel 1 of the RTO / RTE.

4.2.1 Oscilloscope Settings

- Press **PRESET** on the RTO / RTE to obtain a defined initial state.
- Press **AUTOSET** for optimized display.
- Select **MEAS –> SETUP** in the RTO / RTE menu.

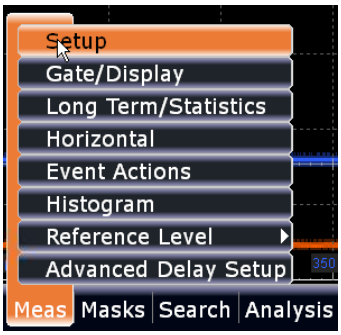


Fig. 4-8: Selecting the Setup dialog from the Measurement menu

- Select the **JITTER** tab

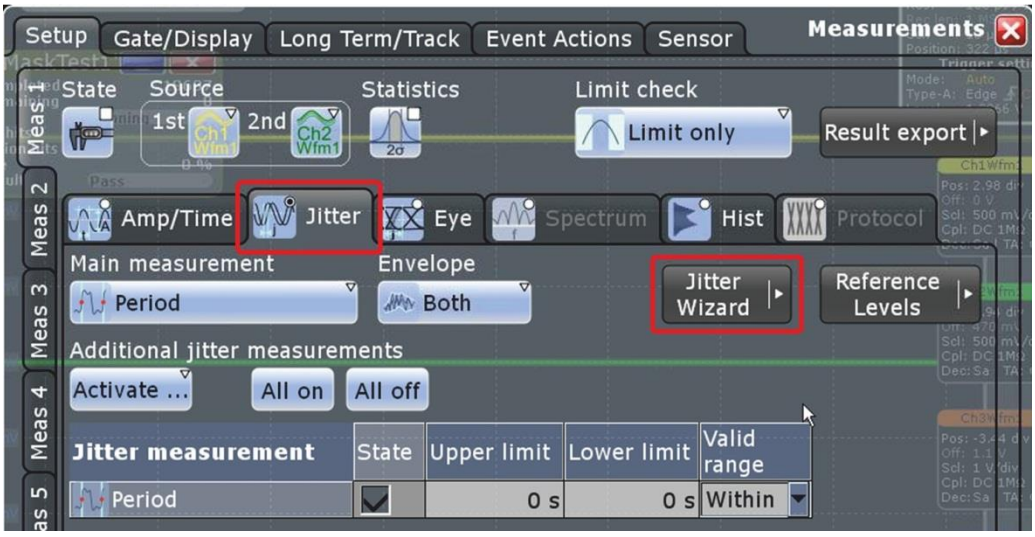


Fig. 4-9: It is convenient to use the Jitter Wizard for defining the test, as this will guide you to the measurement with just three more clicks

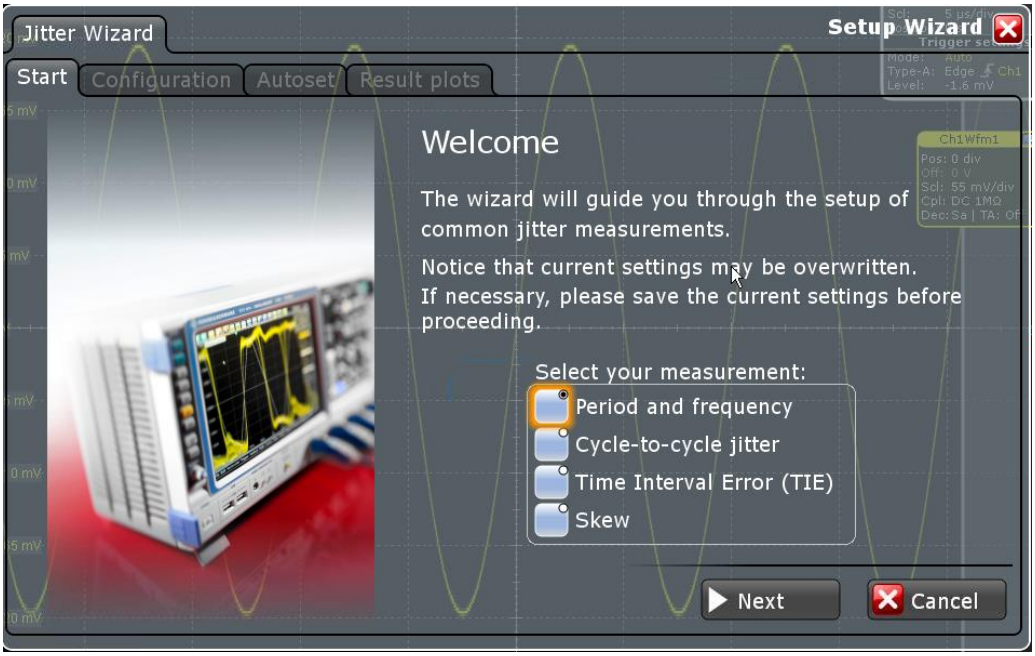


Fig. 4-10: Select a period and frequency measurement in the Jitter Wizard

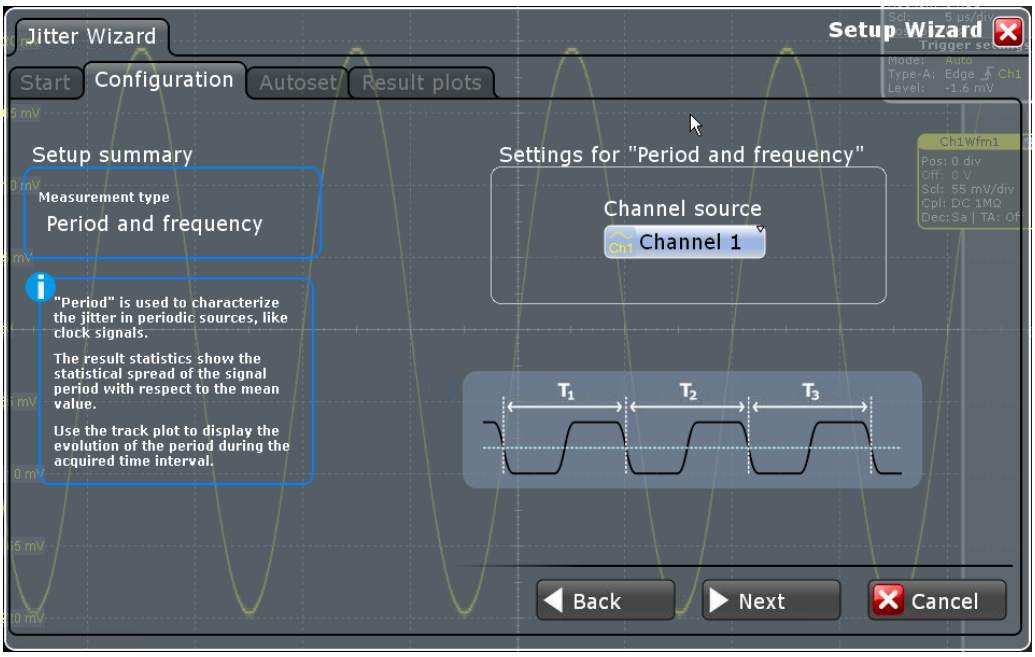


Fig. 4-11: Confirm the pre-selection of Channel 1 by clicking “Next”

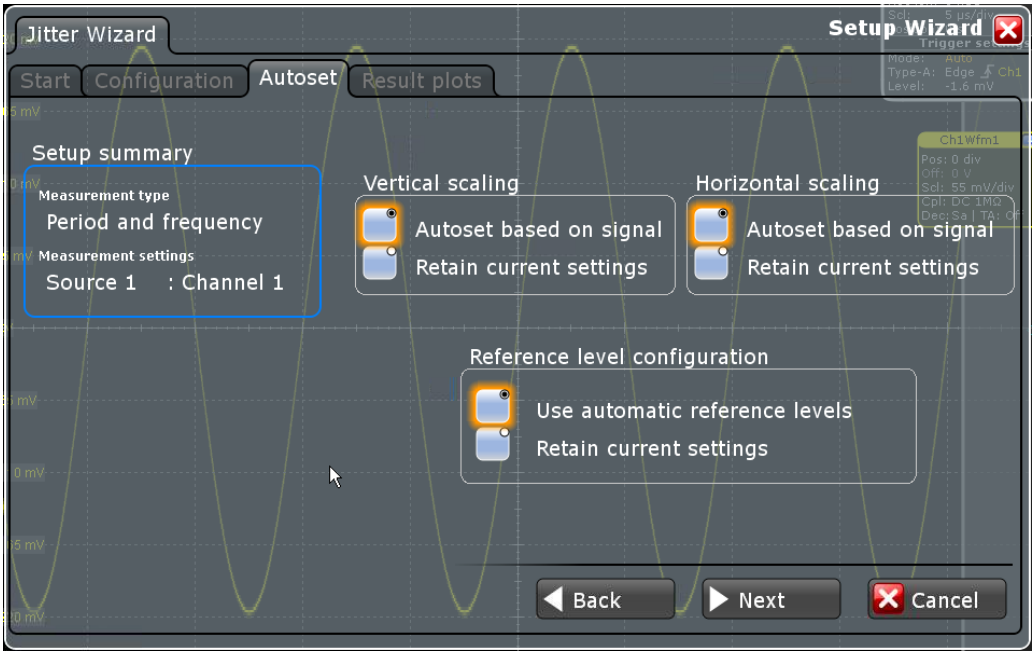


Fig. 4-12: Confirm automatic scaling and auto reference levels by clicking “Next”

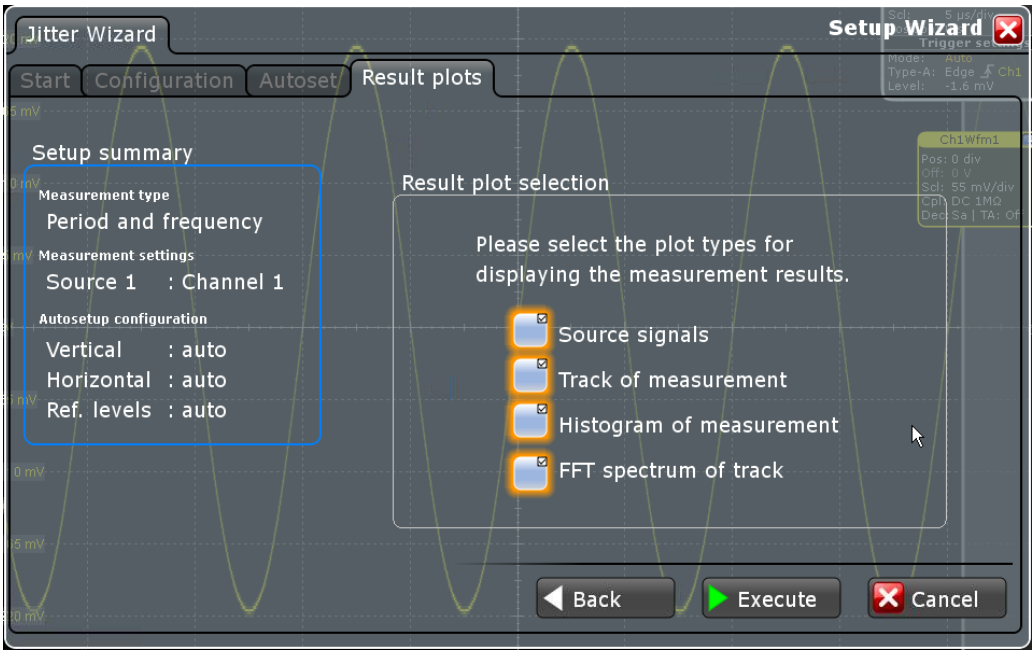


Fig. 4-13: Start the Jitter measurement with all the four suggested plot types by pressing “Execute”

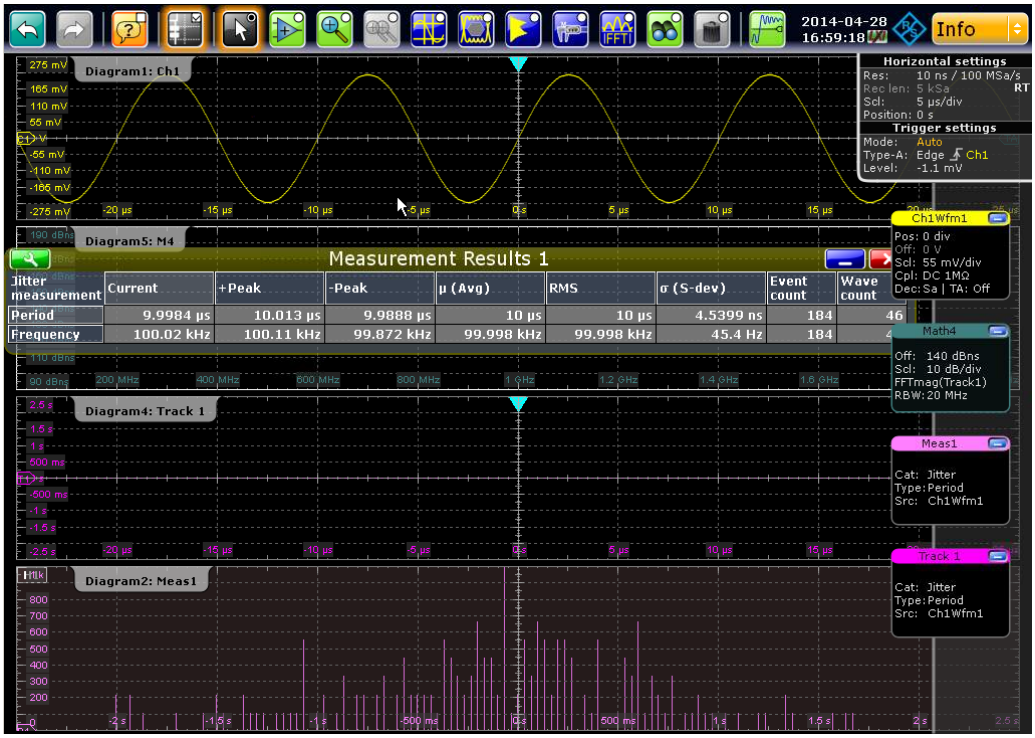


Fig. 4-14:Measurement results showing the period near 10 µs and the corresponding frequency near 100 kHz. The histogram in the lowest measurement window gives indication of the presence of some jitter

- Select **MEAS –> SETUP** in the RTO / RTE menu.

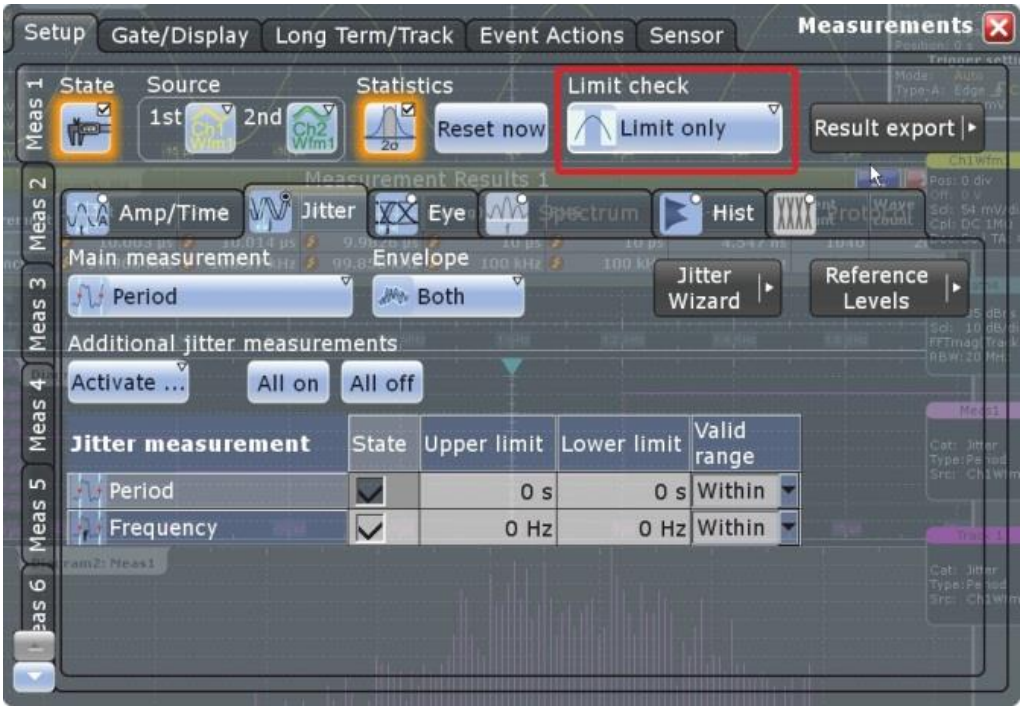


Fig. 4-15: In the Setup dialog, select Limit Check

Fig. 4-16: Turn the Limit Check on by selecting Limit Only

The pulse frequency of f = 100 kHz corresponds to a pulse repetition period of T = 1/f = 10 µs. In order to measure jitter, it must be made sure that any small deviation (e.g., ±0.01 µs) from the 10 µs pulse period is detected.

Therefore, in the setup dialog, define the upper and lower limit of the period to be 10.01 µs and 9.99 µs, according to Fig. 4-17.

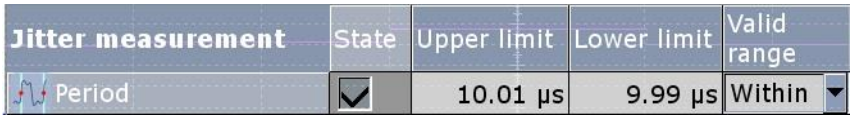


Fig. 4-17: Enter the upper and lower limit by double clicking on the values

If the period exceeds the upper or lower limit, an alarm will be set. The jitter measurement is now active.

To verify the measurement activity, the oscilloscope can be made to beep upon limit violation.

- Select **MEAS –> EVENT ACTIONS** in the RTO / RTE menu.

Fig. 4-18: Selecting the Event Actions dialog from the Measurement menu

Fig. 4-19: Select Beep –> On violation

4.3 EMC32 Settings

4.3.1 Adding the Device to the Device List

The configuration is done in the Device List, which is accessible via the menu **EXTRAS –> DEVICE LIST …**

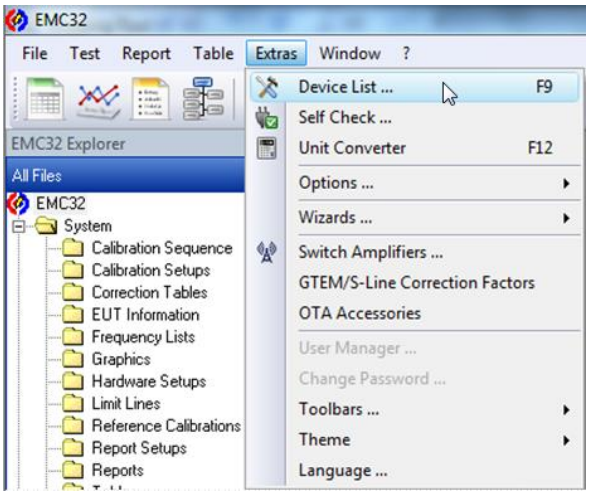


Fig. 4-2: Opening the Device List

or with the function key shortcut “F9”

or via the Device List icon 

Add the **GENERIC MONITORING** device to the right side of the **DEVICE LIST** as **CONFIGURED DEVICE**.

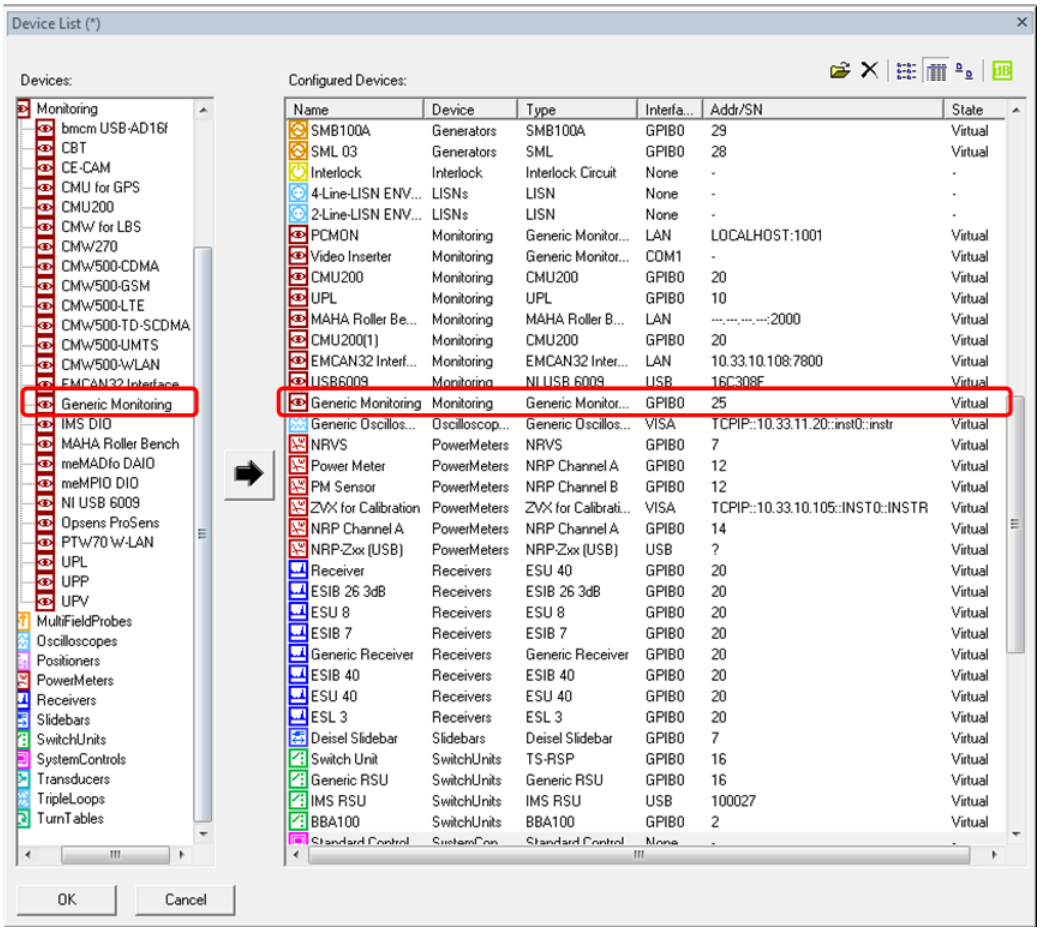


Fig. 4-3: "Generic Monitoring" device added to "Configured Devices"

Single click on the entry and rename **GENERIC MONITORING** to an appropriate Device Name, e.g. **RTO TEST LIMIT**.

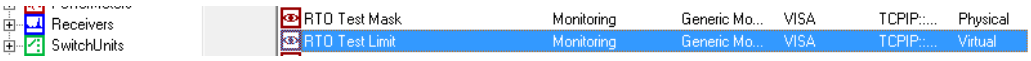


Fig. 4-4: Rename "Generic Monitoring" to "RTO Test Limit"

Note: Please make sure that all necessary instrument drivers, e.g. SMB, NRP-Zxx have been installed, before running an EMS test. If some or all devices are missing, a message box allowing simulation mode enabling will appear.

4.3.1.1 Generic Monitoring Properties

Edit the **RTO TEST LIMIT** properties by double clicking on the menu item. It is defined by six properties:

- General
- Interface Parameters
- General Commands
- Device Programming
- Measurement Queries
- EMS Information

4.3.1.2 General and Interface Parameters Tabs

In the General tab, select the appropriate **INTERFACE TYPE** from a list of addresses or by using the **VISA DEVICE IDENTIFIER** (see Fig. 4-5).
After editing this parameter, close the RTO Limit Test window by pressing OK. Also close the Device List by pressing OK. If there have been significant changes in the Device List, a window pops up, advising to close and restart EMC32-S. Re-open the Device List and activate the RTO Test Limit device by changing the **STATE** from **VIRTUAL** to **PHYSICAL**.

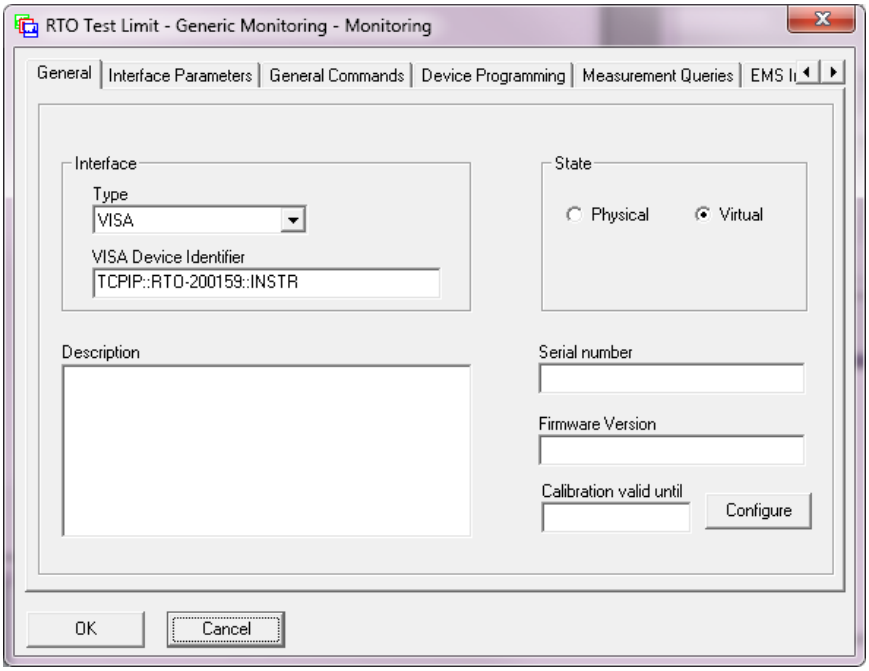


Fig. 4-5: Select Interface Type "VISA"

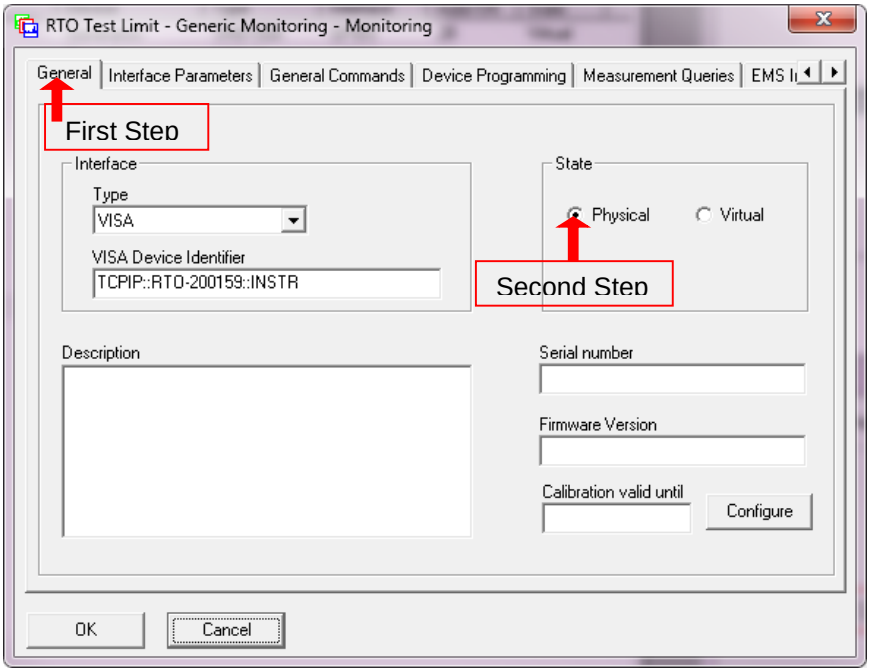


Fig. 4-6: Set State to "Physical"

Change to **INTERFACE PARAMETERS** tab and set the parameters.

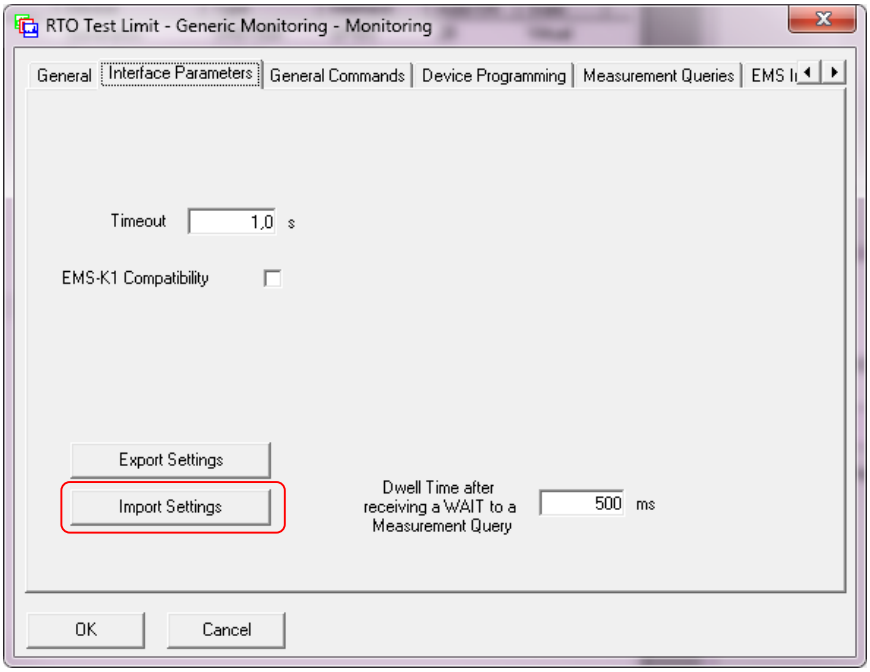


Fig. 4-7: Import settings

Import parameters by clicking **IMPORT SETTINGS**.

In the newly opened dialog box Import Settings, select predefined parameters by clicking the ... button, selecting **RTO LIMIT TEST** and pressing **OK**.

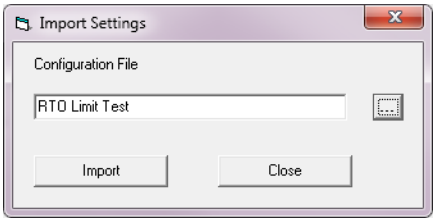


Fig. 4-8: Configuration File to Import

Click on **IMPORT** to load the configuration. The import is completed by pressing OK on the following message window.

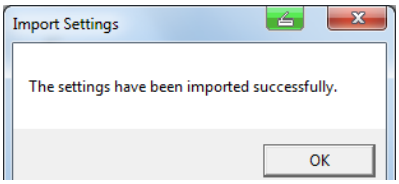


Fig. 4-9: Successful file import

The RTO Limit Test import file contains following lines.

4.3.1.3 General Commands

Commands for the basic configuration of the monitoring device are defined in this tab. The following commands are available:

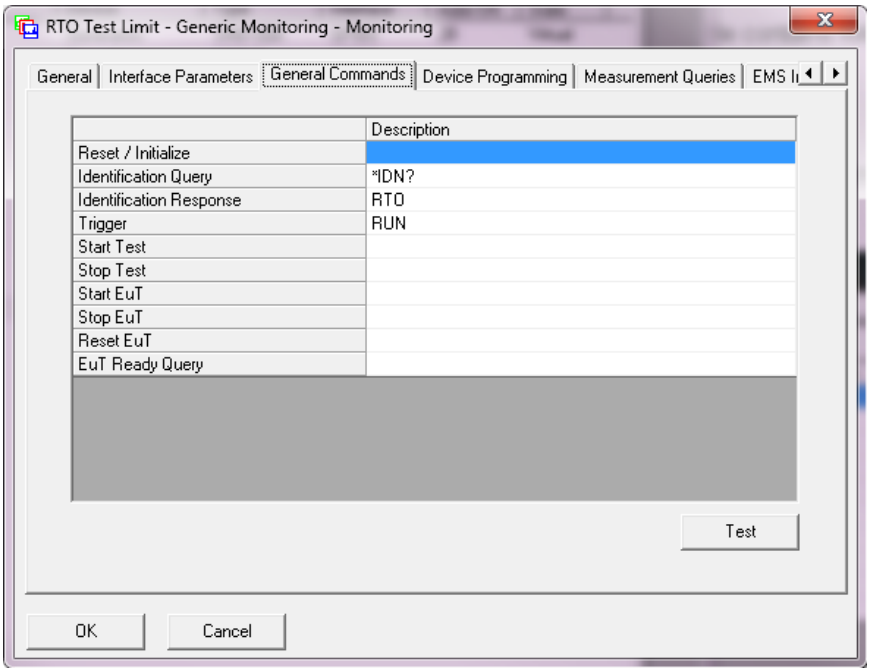


Fig. 4-10: Generic Monitoring Commands

4.3.1.4 Device Programming

This tab contains two commands for activating the limit test.

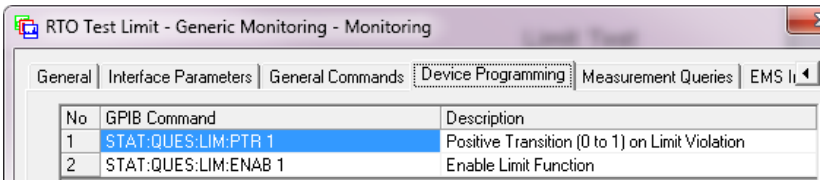


Fig. 4-11: Commands for activating Limit Test

4.3.1.5 Measurement Queries

This tab contains the Limit Test Result (0=PASS, 1=FAIL).

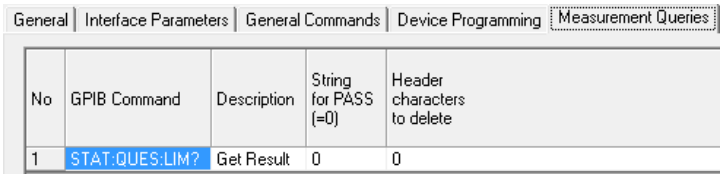


Fig. 4-12: "Measurement Queries" tab with Status Byte Query

4.3.1.6 Generic Monitoring Test Dialog

After pressing the Test button in the **EMS INFORMATION** tab, the following dialog box will be opened, allowing to select an item from the **GENERAL COMMANDS** or **MEASUREMENT QUERIES** list. Select **IDENTIFICATION QUERY** from the **GENERAL COMMANDS** and enter the **TEST COMMAND** "*IDN?". After pressing **TEST COMMAND**, the command is sent to the oscilloscope and the response (RTO ID string) is received. Then, exit this dialog by pressing **CLOSE**.

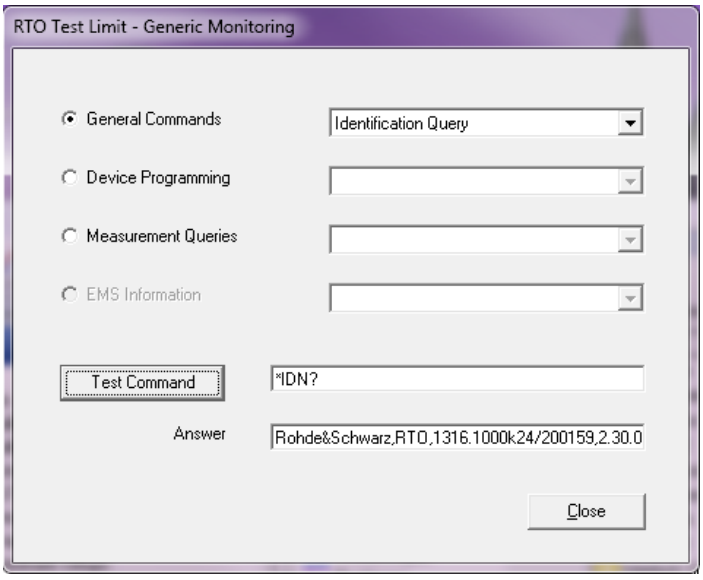


Fig. 4-13: Generic Monitoring Test Dialog

4.4 EUT Monitoring Example

In order to perform the example, a test template for EUT monitoring with an RTO or RTE oscilloscope is required first.

4.4.1 Oscilloscope Monitoring Settings

To generate a new EUT Monitoring Test Template, proceed as shown in Fig. 4-14.

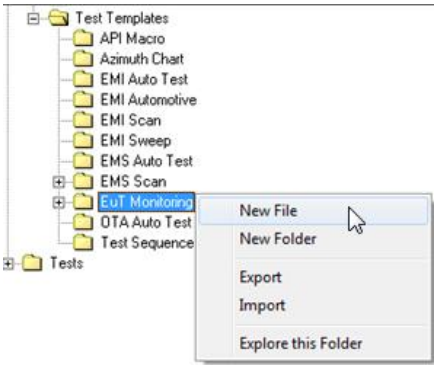


Fig. 4-14: EUT Monitoring Configuration: "New File"

In the EMC32 Explorer, select File **–>** Test Template open/new. Right-click on the **EUT MONITORING** menu item and select **NEW FILE**. A new window for configuring the RTO Test Limit parameters pops up.

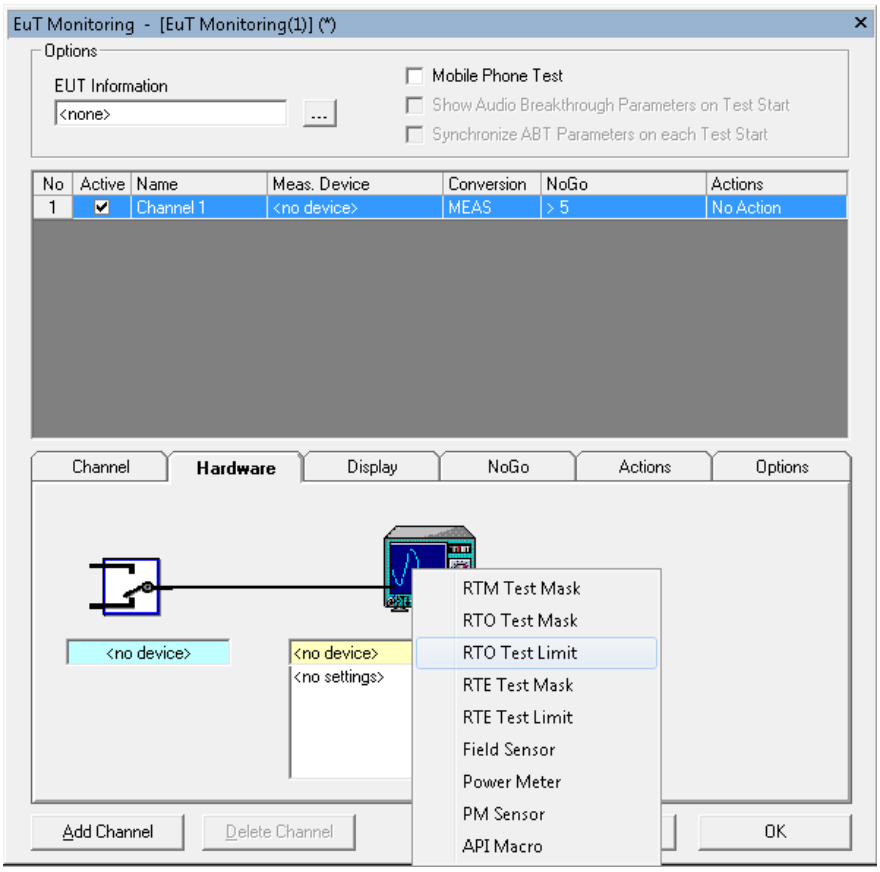


Fig. 4-15: EUT Monitoring configuration: RTO Test Limit selection

Right-click on the oscilloscope device icon in the **HARDWARE** tab and select **RTO TEST LIMIT** from the list.

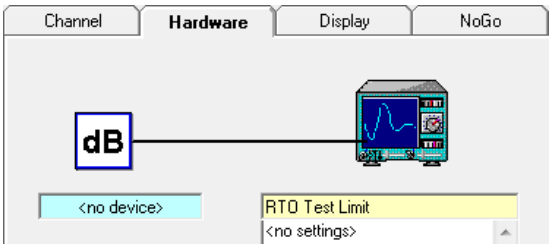


Fig. 4-16: EUT Monitoring Configuration: Selected Device

Then left-click on the icon to configure the device in the following pop-up window, according to Fig. 4-17: select “Send Trigger Command”, and specify the Measurement Query as “Get Result”. Check the **DEVICE PROGRAMMING** items **POSITIVE TRANSITION…** and **ENABLE LIMIT FUNCTION**.

.

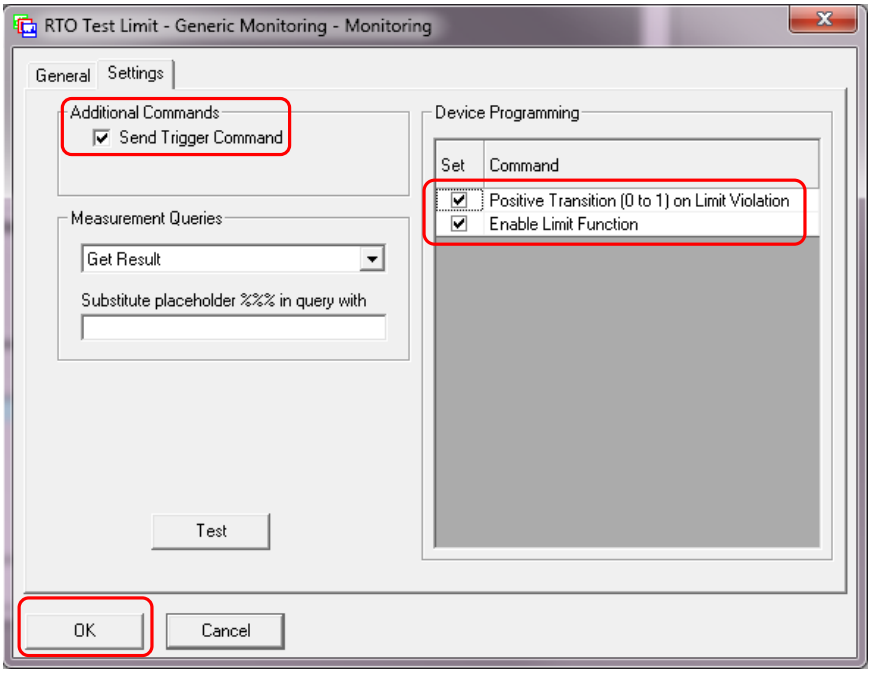


Fig. 4-17: EUT Monitoring Configuration: Device Settings

Press **OK** to complete the **RTO TEST LIMIT** configuration, which appears in the EUT Monitoring configuration in Fig. 4-18.

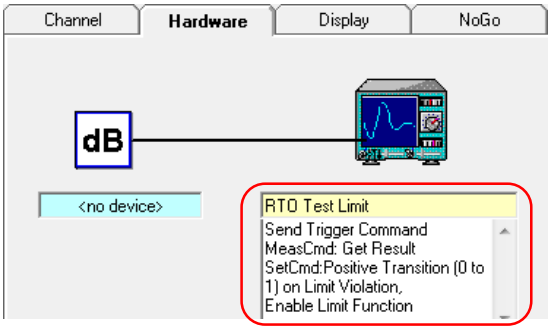


Fig. 4-18: EUT Monitoring Configuration

After configuring **RTO TEST LIMIT**, go to the **CHANNEL** tab and select **TRIGGER MODE –> BEFORE DWELL**.

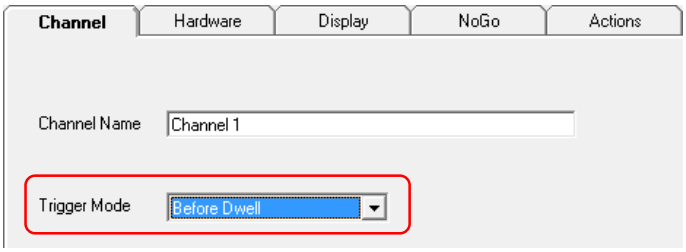


Fig. 4-19: EUT Monitoring Configuration: "Trigger Mode" Selection

In the **NoGo** tab, set **NoGo Type** to **Above Limit**, set **Limit Value** = 0.50000 and press **OK** to save the **RTO Limit Test** configuration.

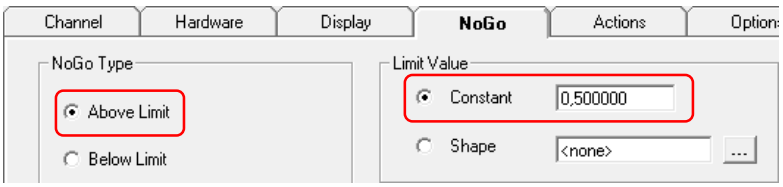


Fig. 4-20: EUT Monitoring Configuration: "Limit Value"

4.4.2 Actions

If the measurement should be stopped after a limit violation occurred, add **Stop Test** to the **Action on NoGo** item.

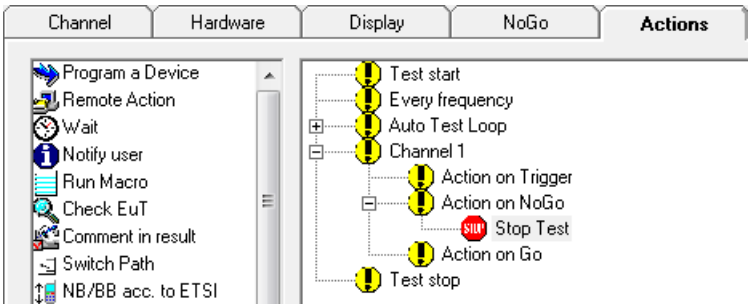


Fig. 4-21: Action on NoGo → Stop Test

4.4.3 Start Test

Download DEVICECONFIGURATION_FILES.ZIP from the 1MA242 application note page and unzip **EUT Test.EMSConfiguration** to **<EMC32 Directory>\EMC32\System\Test Templates\EMS Scan\EN61000-4-3** and **RTO Limit Test.EUTConfiguration** , **RTE Limit Test.*** to **<EMC32 Directory>\EMC32\System\Test Templates\EUT Monitoring**.

Note: In case of Windows7 and the default data directory **C:\ProgramData** it is necessary to make it visible first by unchecking the **Hide Protected Operating Files** in the **Folder Options**.

In the EMC32 Explorer, right-click on the menu item **Test Template –> EMS Scan –> EN61000-4-3** (EMS Radiated) **–> EUT Test** and select **New Test**.

Note: In case of Windows7 and the default data directory **C:\ProgramData** it is necessary to make it visible first by unchecking the **Hide Protected Operating Files** in the **Folder Options**).

In the EMC32 Explorer, right-click on the menu item **Test Template –> EMS Scan –> EN61000-4-3** (EMS Radiated) **–> EUT Test** and select **New Test**.

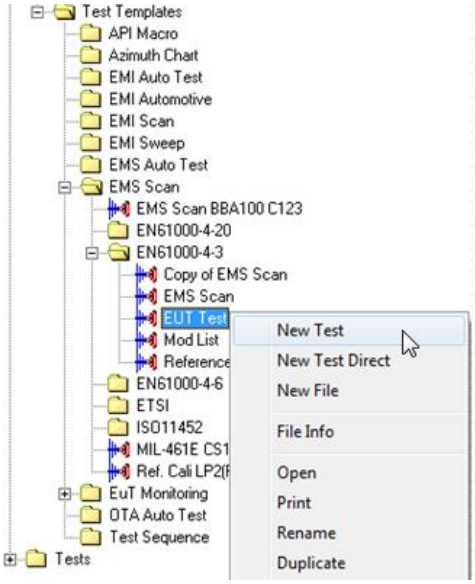


Fig. 4-22: Start EMS Scan Test Template as New Test

A **NEW TEST** window with EMS Radiated specific default parameters pops up.

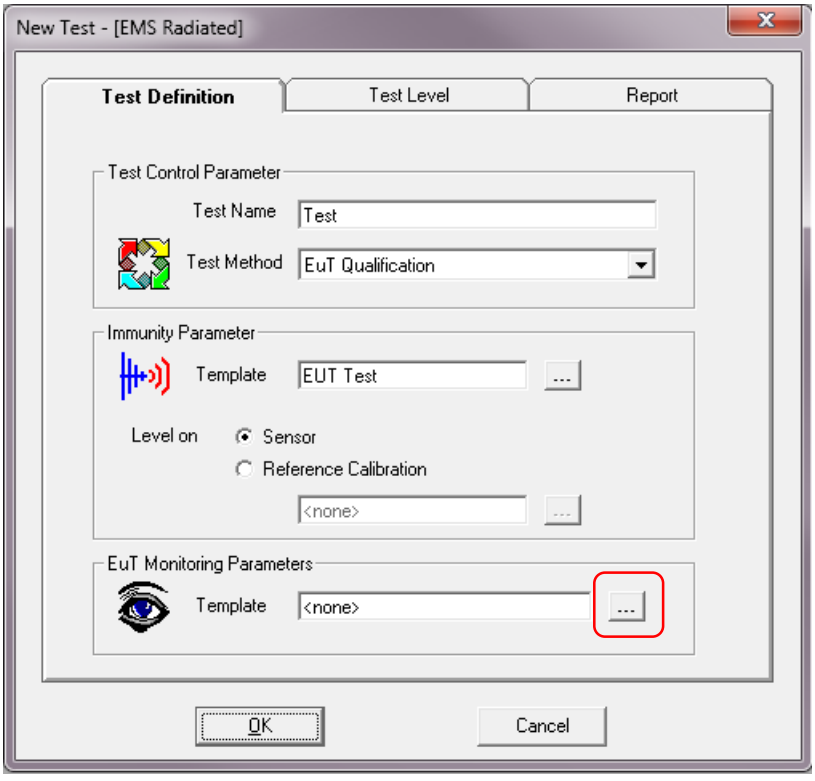


Fig. 4-23: New Test dialog

After pressing the **EUT MONITORING PARAMETERS –>** ... icon, the EuT Monitoring Open window pops up, which allows to select the **RTO LIMIT TEST**(.EUTConfiguration).

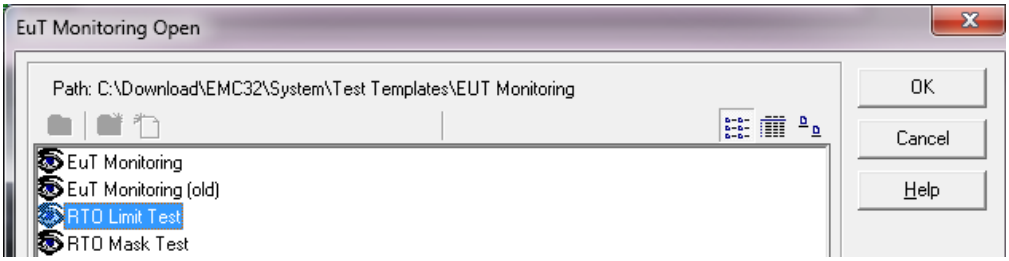


Fig. 4-24: EUT monitoring File location

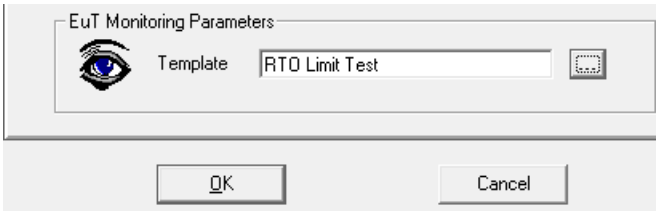


Fig. 4-25: New Test dialog with "RTO Limit Test"

After pressing **OK**, the test is ready for execution.

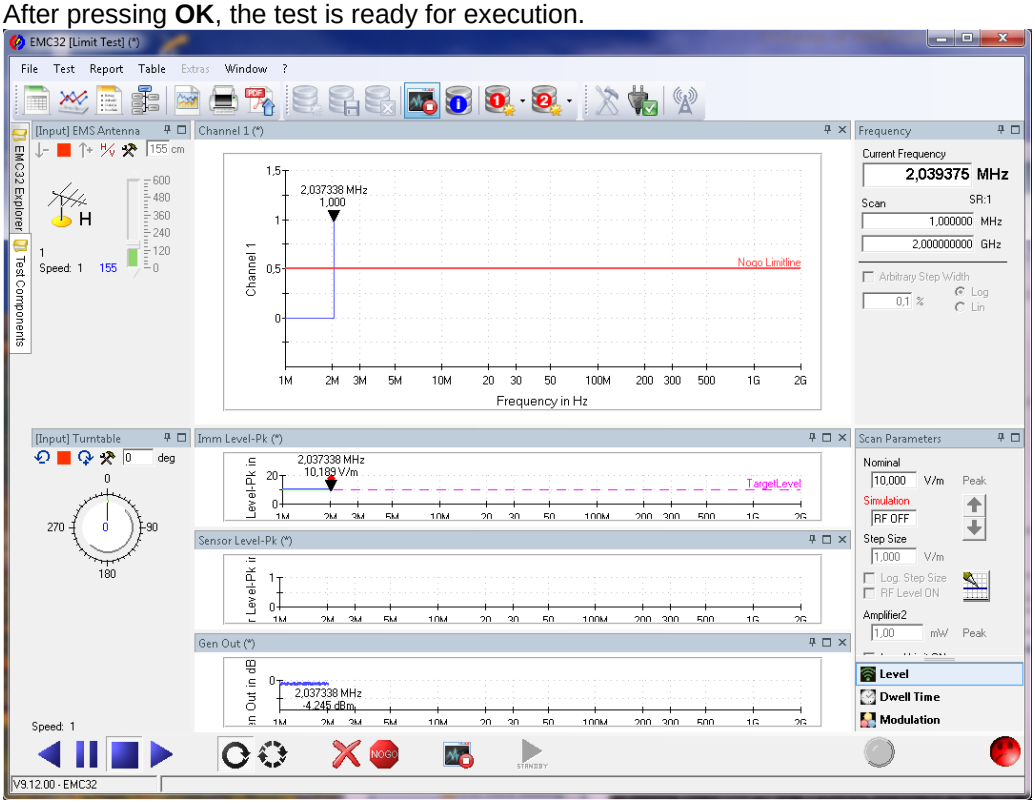


Fig. 4-26: EMC32 Test Execution

The upper graph in Fig. 4-26 (see also Fig. 4-27) shows how the Limit value jumps from 0 to 1 when the signal violates the limit. The logical units 0 and 1 are interpreted as 0.0 and 1.0 which exceeds the pre-defined 0.5 limit line, causing a **FAIL** result.

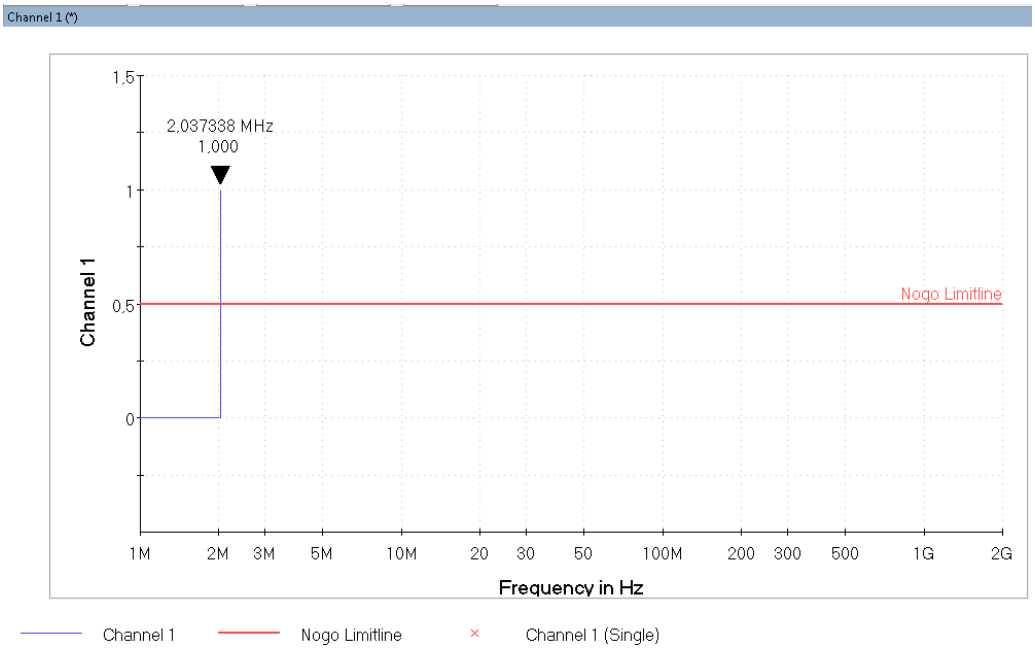


Fig. 4-27: EUT Channel 1 measurement result

5 EMC32 Limit Testing

In case an instrument does not have the limit test capability, e.g. RTM, EMC32 can handle the limit checking instead. The performance will slightly be reduced as compared to use of RTO / RTE.

5.1 RMS Measurement

This example shows how to set up the RTM oscilloscope for an RMS measurement and configure EMC32 to stop the measurement in case the RMS value drops below a certain limit.

5.1.1 Oscilloscope Settings

Press the **MEAS** button and select **MEAS. TYPE**, e.g. **RMS**. Connect the pulse output with **CH1** input via probe and press **AUTOSET**.

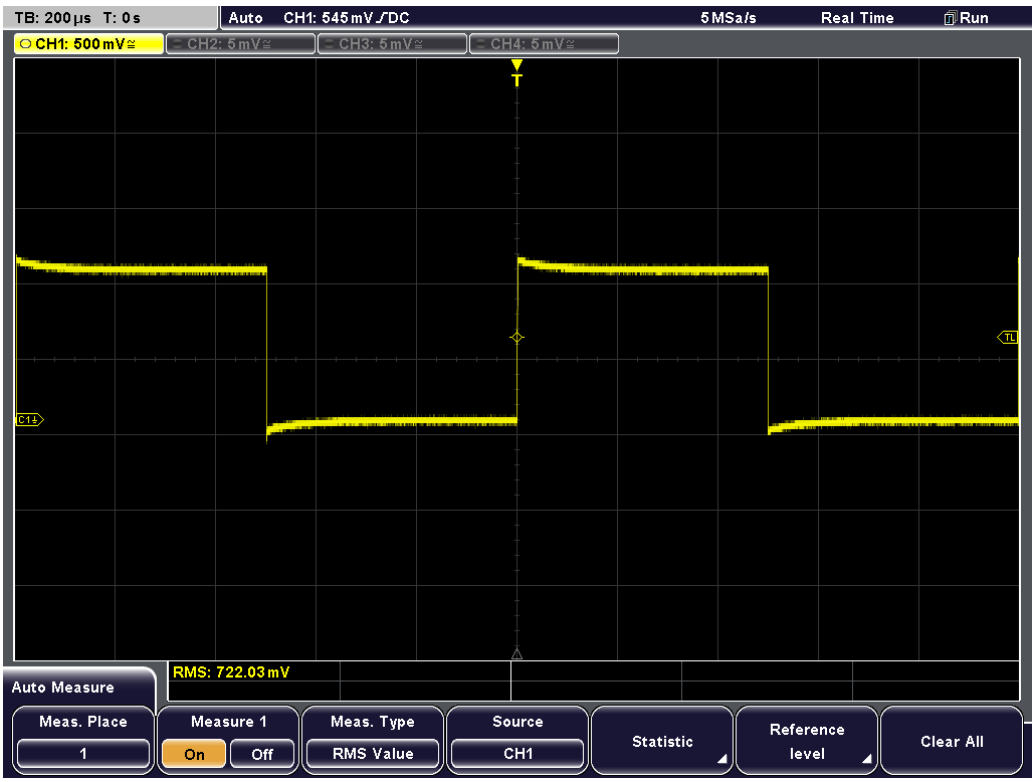


Fig. 5-1: RMS Measurement on RTM

5.2 EMC32 Settings

5.2.1 Adding the Device to the Device List

The configuration is done in the Device List, which is accessible via the menu **EXTRAS –> DEVICE LIST …**

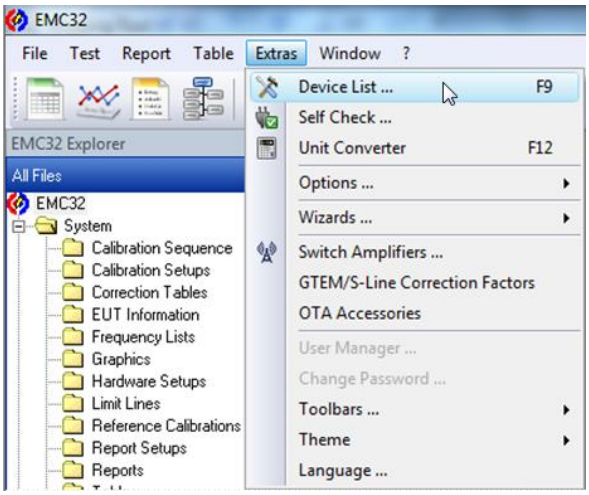


Fig. 5-2: Opening the Device List

or with the function key shortcut “F9”

or via the Device List icon 

Add the **GENERIC MONITORING** device to the right side of the **DEVICE LIST** as **CONFIGURED DEVICE**.

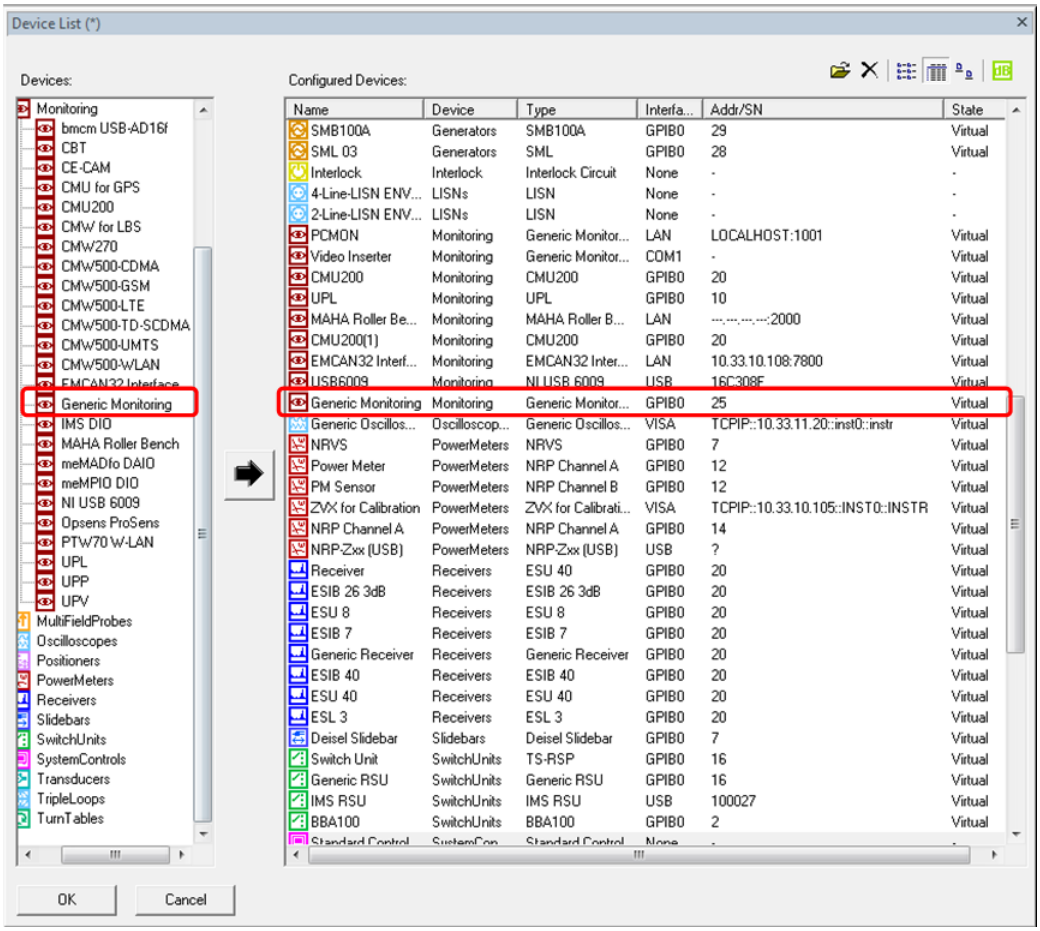


Fig. 5-3: "Generic Monitoring" device added to "Configured Devices"

Single click on the entry and rename **GENERIC MONITORING** to an appropriate Device Name, e.g. **RTM TEST LIMIT**.

Fig. 5-4: Rename "Generic Monitoring" to "RTM Test Limit"

Note: Please make sure that all necessary instrument drivers, e.g. SMB, NRP-Zxx have been installed, before running an EMS test. If some or all devices are missing, a message box allowing simulation mode enabling will appear.

5.2.1.1 Generic Monitoring Properties

Edit the **RTM TEST LIMIT** properties by double clicking on the menu item. It is defined by six properties:

- General
- Interface Parameters
- General Commands
- Device Programming
- Measurement Queries

5.2.1.2 General and Interface Parameters Tabs

In the General tab, select the appropriate **INTERFACE TYPE** from a list of addresses or by using the **VISA DEVICE IDENTIFIER** (see Fig. 4-6).
After editing this parameter, close the RTM Limit Test window by pressing OK. Also close the Device List by pressing OK. If there have been significant changes in the Device List, a window pops up, advising to close and restart EMC32-S. Re-open the Device List and activate the RTM Test Limit device by changing the **STATE** from **VIRTUAL** to **PHYSICAL**.

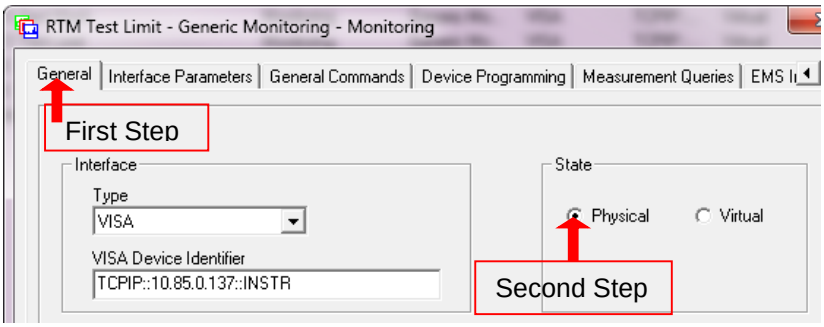


Fig. 5-5: Set State to "Physical"

Change to **INTERFACE PARAMETERS** tab and set the parameters.

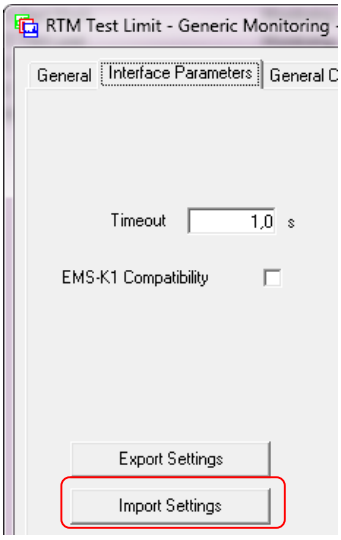


Fig. 5-6: Import settings

Import parameters by clicking **IMPORT SETTINGS**.

In the newly opened dialog box Import Settings, select predefined parameters by clicking the ... button, selecting **RTM LIMIT TEST** and pressing **OK**.

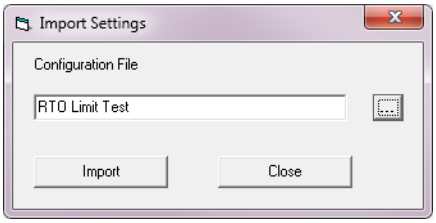


Fig. 5-7: Configuration File to Import

Click on **IMPORT** to load the configuration. The import is completed by pressing OK on the following message window.

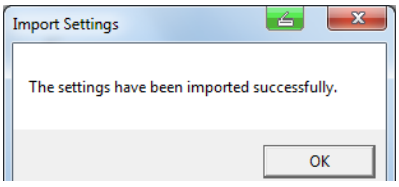


Fig. 5-8: Successful file import

The RTM Limit Test import file contains following lines.

5.2.1.3 General Commands

Commands for the basic configuration of the monitoring device are defined in this tab. The following commands are available:

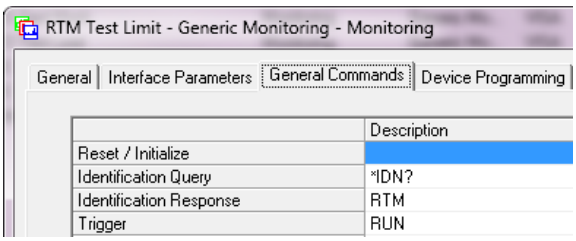


Fig. 5-9: Generic Monitoring Commands

5.2.1.4 Device Programming

Not used in this example.

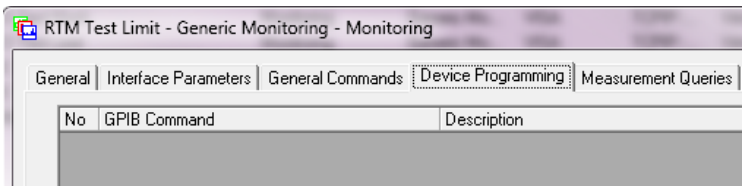


Fig. 5-10: Commands for activating Limit Test

5.2.1.5 Measurement Queries

This tab contains the measurement query command.

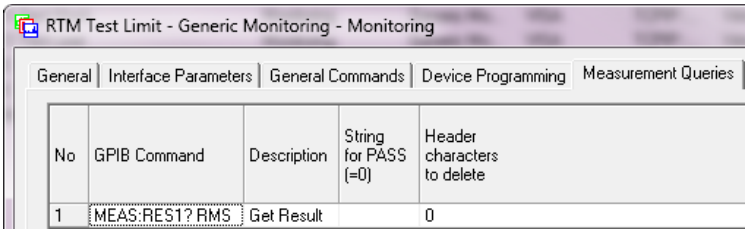


Fig. 5-11: "Measurement Queries" tab with RMS measurement command

Note: The **STRING FOR PASS** field is empty since the PASS / FAIL decision of a measurement result is made by the EMC32 software. In case a scope offers mask or limit detection feature, this field will contain usually either "PASS" or "0".

5.2.1.6 Generic Monitoring Test Dialog

After pressing the Test button in the **MEASUREMENT QUERIES** tab, the following dialog box will be opened. , allowing to select an item from the **GENERAL COMMANDS** or list. Select **GET RESULT** from the **MEASUREMENT QUERIES** and enter the command “MEAS:RES1? RMS”. After pressing **TEST COMMAND**, the command is sent to the oscilloscope and the response “7.224944E-01” is received. Then, exit this dialog by pressing **CLOSE**.

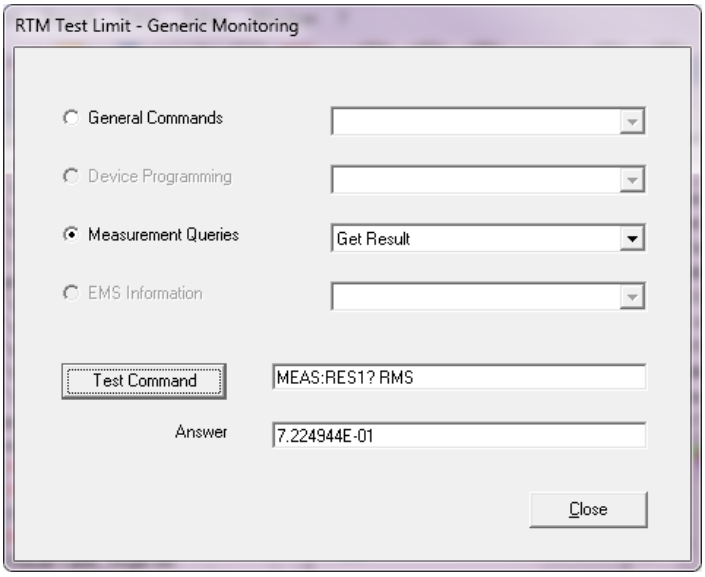


Fig. 5-12: Generic Monitoring Test Dialog

5.3 EUT Monitoring Example

In order to perform the example, a test template for EUT monitoring with an RTM oscilloscope is required first.

5.3.1 Oscilloscope Monitoring Settings

To generate a new EUT Monitoring Test Template, proceed as shown in Fig. 4-14.

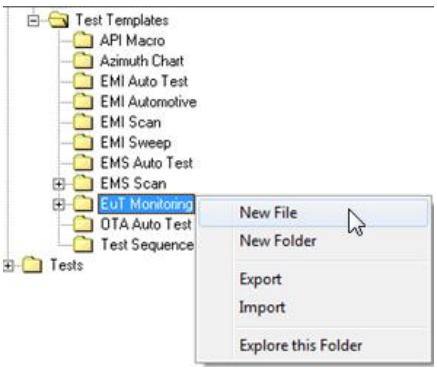


Fig. 5-13: EUT Monitoring Configuration: “New File”

In the EMC32 Explorer, select **FILE –> TEST TEMPLATE OPEN/NEW…**. Right-click on the **EUT MONITORING** menu item and select **NEW FILE**. A new window for configuring the RTM Test Limit parameters pops up.

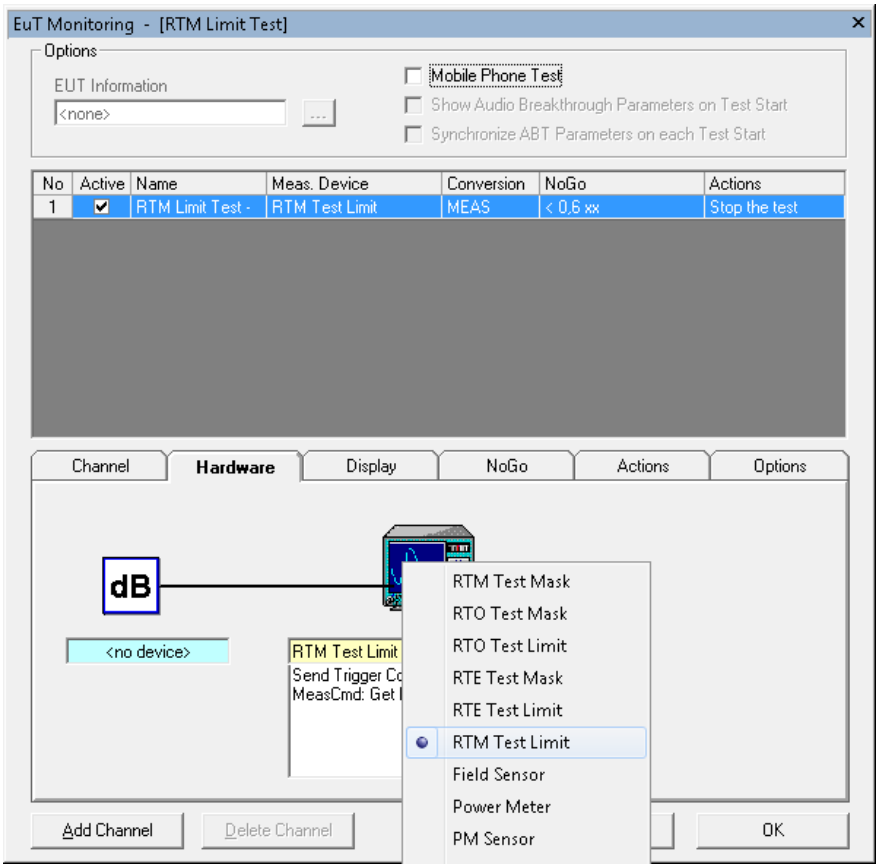


Fig. 5-14: EUT Monitoring configuration: RTM Test Limit selection

Right-click on the oscilloscope device icon in the **HARDWARE** tab and select **RTM TEST LIMIT** from the list.

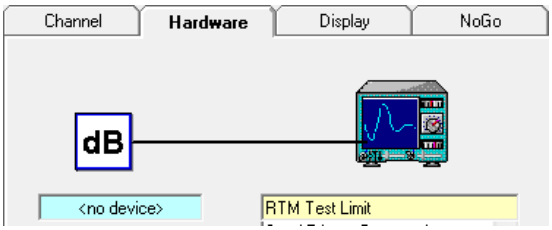


Fig. 5-15: EUT Monitoring Configuration: Selected Device

Then (left-)click on the icon to configure the device in the following pop-up window, according to Fig. 4-17: select “Send Trigger Command”, and specify the Measurement Query as “Get Result”. Check the **DEVICE PROGRAMMING** items **POSITIVE TRANSITION…** and **ENABLE LIMIT FUNCTION**.

.

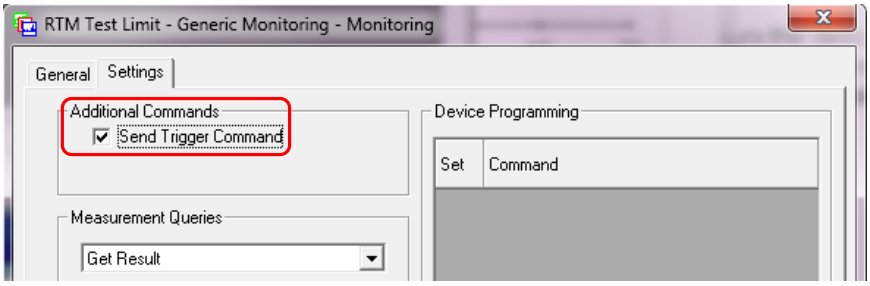


Fig. 5-16: EUT Monitoring Configuration: Device Settings

Press **OK** to complete the **RTM TEST LIMIT** configuration, which appears in the EUT Monitoring configuration in Fig. 4-18.

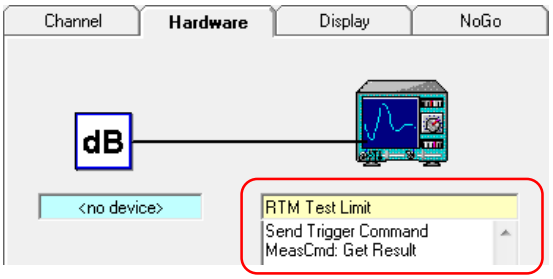


Fig. 5-17: EUT Monitoring Configuration

After configuring **RTM TEST LIMIT**, go to the **CHANNEL** tab and select **TRIGGER MODE –> BEFORE DWELL**.

Fig. 5-18: EUT Monitoring Configuration: "Trigger Mode" Selection

In the **NoGo** tab, set **NoGo Type** to **Below Limit**, set **Limit Value** = 0.60000 and press **OK** to save the **RTM Limit Test** configuration.

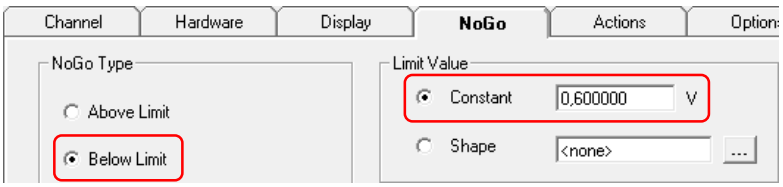


Fig. 5-19: EUT Monitoring Configuration: "Limit Value"

5.3.2 Actions

If the measurement should be stopped after a limit violation occurred, add **Stop Test** to the **Action on NoGo** item.

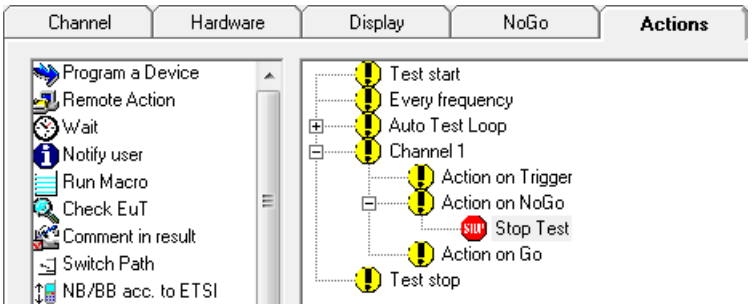


Fig. 5-20: Action on NoGo → Stop Test

5.3.3 Start Test

Download DEVICECONFIGURATION_FILES.ZIP from the 1MA242 application note page and unzip **EUT Test.EMSConfiguration** to **<EMC32 Directory>\EMC32\System\Test Templates\EMS Scan\EN61000-4-3** and **RTO Limit Test.EUTConfiguration** , **RTE Limit Test.*** to **<EMC32 Directory>\EMC32\System\Test Templates\EUT Monitoring**.

Note: In case of Windows7 and the default data directory **C:\ProgramData** it is necessary to make it visible first by unchecking the **Hide Protected Operating Files** in the **Folder Options**.

In the EMC32 Explorer, right-click on the menu item **Test Template –> EMS Scan –> EN61000-4-3** (EMS Radiated) **–> EUT Test** and select **New Test**.

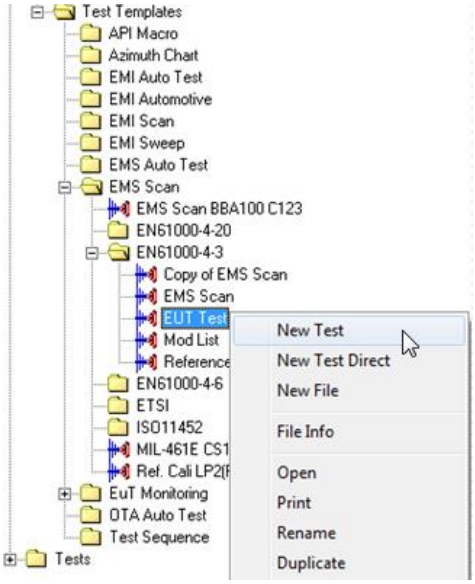


Fig. 5-21: Start EMS Scan Test Template as New Test

A **NEW TEST** window with EMS Radiated specific default parameters pops up.

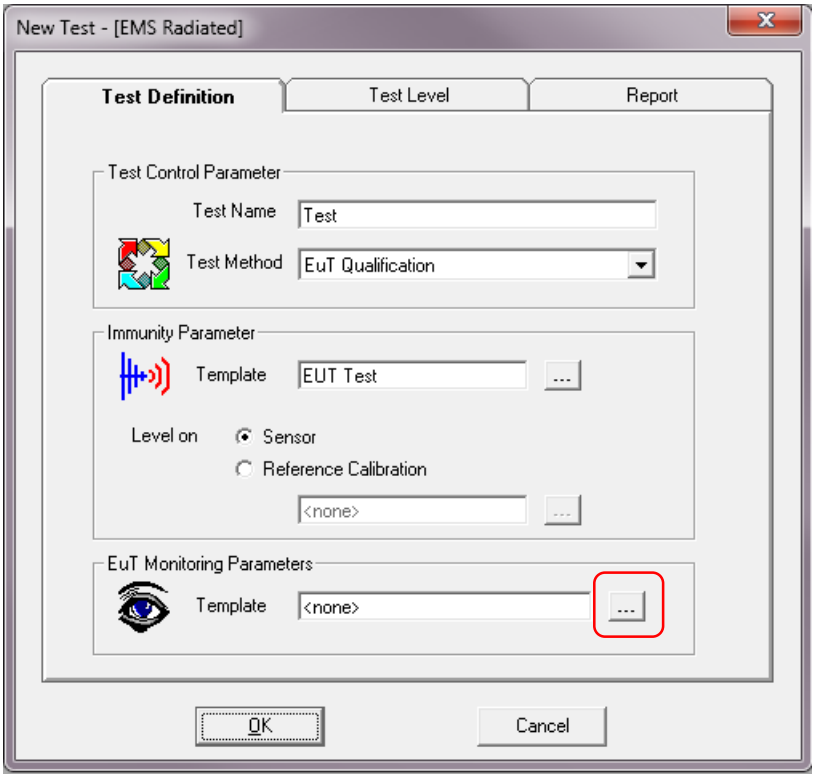


Fig. 5-22: New Test dialog

After pressing the **EUT MONITORING PARAMETERS –>** ... icon, the EuT Monitoring Open window pops up, which allows to select the **RTM LIMIT TEST**(.EUTConfiguration).

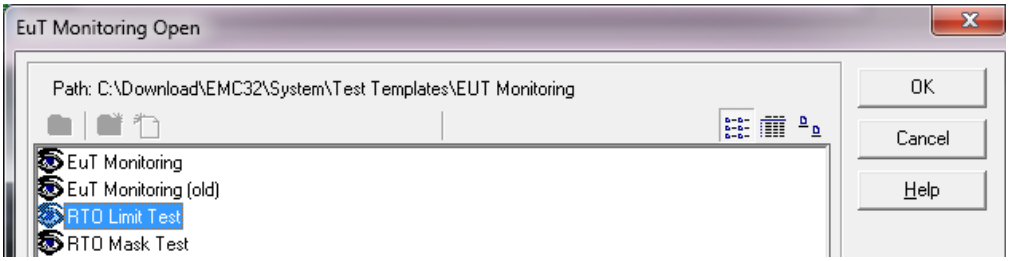


Fig. 5-23: EUT monitoring File location

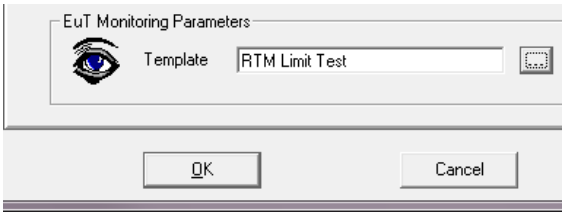


Fig. 5-24: New Test dialog with "RTM Limit Test"

After pressing **OK**, the test is ready for execution.

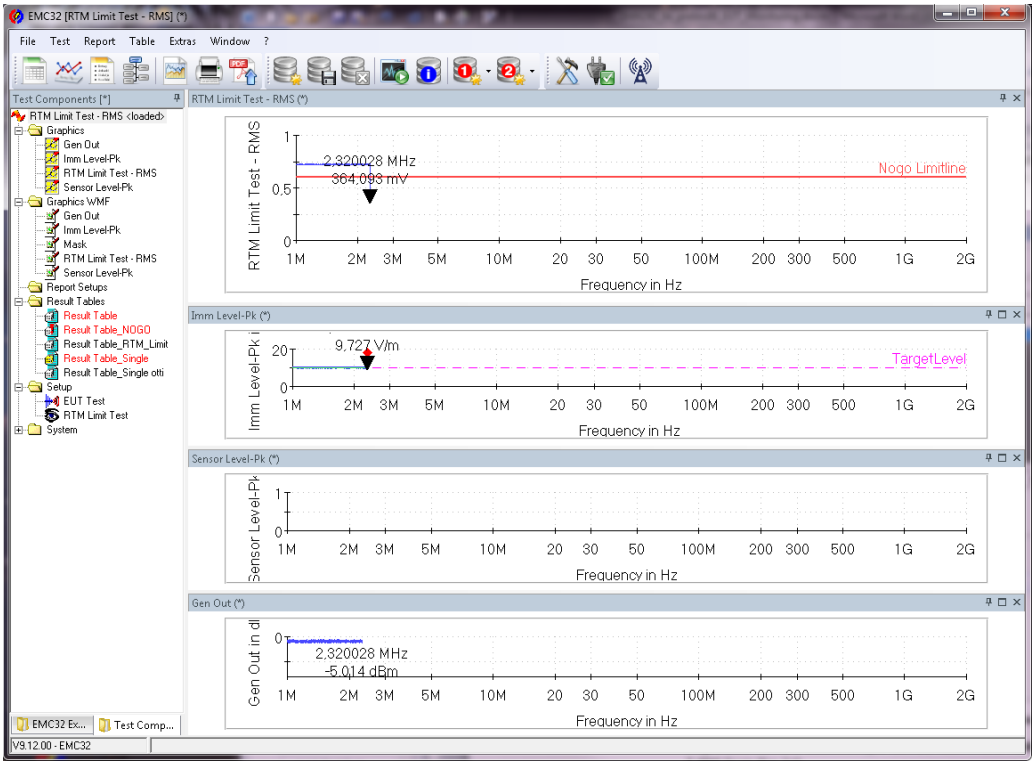


Fig. 5-25: EMC32 Test Execution

The upper graph in Fig. 4-26 (also see Fig. 4-27) shows how the RMS voltage drops from 722 mV below the 600 mV limit line. The measurement is stopped immediately due to the **ACTION ON NOGO –> STOP TEST** (see Fig. 4-21)

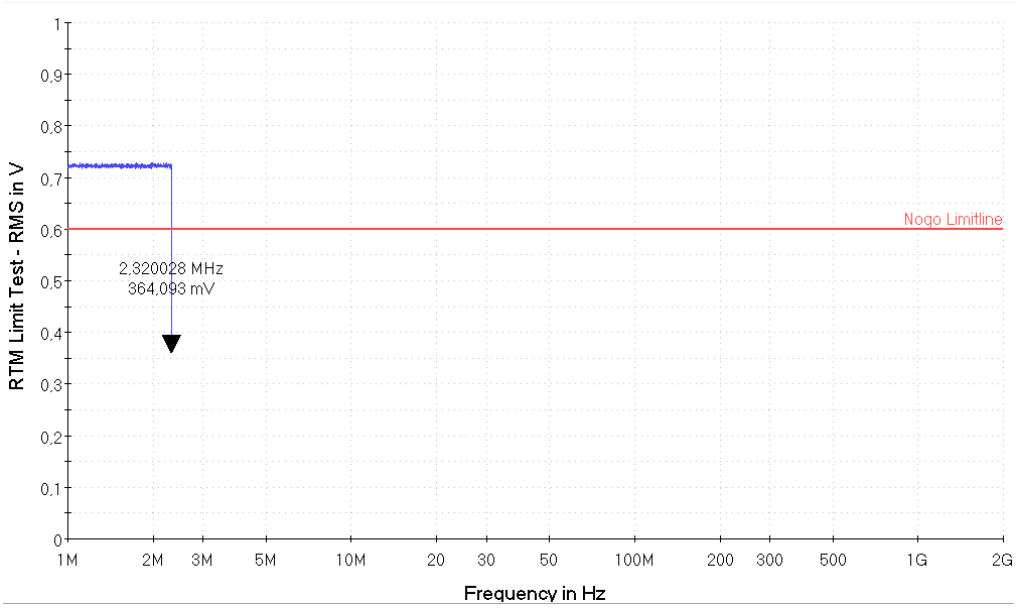


Fig. 5-26: EUT Channel 1 measurement result

6 Literature

[1] R&S®RTO Digital Oscilloscope User Manual

[2] R&S®RTE Digital Oscilloscope User Manual

[3] R&S®RTM Digital Oscilloscope User Manual

[4] R&S®EMC32 Measurement Software User Manual

[5] Application Note 1MA212 – Conducted EMS and EMI Measurements with R&S®EMC32

[6] Application Note 1TD05 - EMI Debugging with the R&S®RTO and R&S®RTE Oscilloscopes

[7] Application Note 1SP06 - Interactive EMI Measurements with R&S©EMC32-K24

7 Additional Information

Please send comments or suggestions about this application note to TM-Applications@rohde-schwarz.com.

8 Ordering Information

Ordering Information		
Digital Oscilloscope		
R&S®RTO1002	600 MHz, 10 Gsample/s, 20/40 Msamples, 2 channels	1316.1000.02
R&S®RTO1012	600 MHz, 10 Gsample/s, 20/40 Msamples, 2 channels	1316.1000.02
R&S®RTO1012	1 GHz, 10 Gsample/s, 20/40 Msamples, 2 channels	1316.1000.12
R&S®RTO1014	1 GHz, 10 Gsample/s, 20/80 Msamples, 4 channels	1316.1000.14
R&S®RTO1022	2 GHz, 10 Gsample/s, 20/40 Msamples, 2 channels	1316.1000.22
R&S®RTO1024	2 GHz, 10 Gsample/s, 20/80 Msamples, 4 channels	1316.1000.24
R&S®RTO1044	4 GHz, 10 Gsample/s, 20/80 Msamples, 4 channels	1316.1000.44
R&S®RTE1022	200 MHz, 5 Gsample/s, 10/20 Msamples, 2 channels	1316.2500.22
R&S®RTE1024	200 MHz, 5 Gsample/s, 10/40 Msamples, 4 channels	1316.2500.24
R&S®RTE1032	350 MHz, 5 Gsample/s, 10/20 Msamples, 2 channels	1316.2500.32
R&S®RTE1034	350 MHz, 5 Gsample/s, 10/40 Msamples, 4 channels	1316.2500.34
R&S®RTE1052	500 MHz, 5 Gsample/s, 10/20 Msamples, 2 channels	1316.2500.52
R&S®RTE1054	500 MHz, 5 Gsample/s, 10/40 Msamples, 4 channels	1316.2500.54
R&S®RTE1102	1 GHz, 5 Gsample/s, 10/20 Msamples, 2 channels	1316.2500.02
R&S®RTE1104	1 GHz, 5 Gsample/s, 10/40 Msamples, 4 channels	1316.2500.04
R&S®RTM2032	350 MHz, 2.5 Gsample/s, 10/20 Msamples, 2 channels	5710.0999.32
R&S®RTM2034	350 MHz, 2.5 Gsample/s, 10/20 Msamples, 4 channels	5710.0999.34
R&S®RTM2052	500 MHz, 5 Gsample/s, 10/20 Msamples, 2 channels	5710.0999.52
R&S®RTM2054	500 MHz, 5 Gsample/s, 10/20 Msamples, 4 channels	5710.0999.54
R&S®RT-ZS20	1.5 GHz, active probe, 1 MΩ, 0.8 pF, R&S®ProbeMeter, micro button	1410.3502.02
R&S®RT-ZD20	1.5 GHz, active differential probe, 1 MΩ, 0.6 pF, R&S®ProbeMeter, micro button	1410.4409.02
Measurement Software		
R&S®EMC32-S	EMS Measurement Software for Conducted and Radiated Susceptibility	1119.4638.02

About Rohde & Schwarz

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