Shielding Effectiveness Measurement

Application Note

Products:

- R&S®EMC32-K48

This application note shows all necessary settings for measuring shielding effectiveness using the R&S®EMC32-K48 option via R&S®EMC32 Measurement Software.

Note:

Please find the most up-to-date document on our homepage
http://www.rohde-schwarz.com/appnote/

Application Note
Jimmy Goh
8.2015 – 1.00

ROHDE&SCHWARZ

Table of Contents

1 Overview

This document describes the functionalities for R&S®EMC32-K48 option in R&S®EMC32 platform which have to be done to support the shielding effectiveness test method.

The R&S®EMC32 software offers the following applications:

- Provide control for instruments (RF generator, amplifier, switch units, spectrum analyzer, network analyzer)
- Perform reference level testing of system and measurement protocol as recommended by test standard
- Perform EUT Test and Measurement automatically
- Evaluate and display real-time value of the measurement
- Generate report

The R&S®EMC32-K48 option requires R&S®EMC32-S Main Option (EMS Scan Template) and R&S®EMC32-K4 option (EMS Auto Test).

Multi-user licensee should purchase R&S®EMC32MK48 option.

The following abbreviation are used in the following text:

- R&S®EMC32 software is referred to as EMC32
- R&S®EMC32-S software option is referred to as EMC32-S
- R&S®EMC32-K4 software option is referred to as EMC32-K4
- R&S®EMC32-K48 software option is referred to as EMC32-K48
- R&S®EMC32MK48 software option is referred to as EMC32MK48
- Shielding Effectiveness is referred to as SE
- Equipment under test is referred to as EUT
- Radio frequency is referred to as RF
- Electromagnetic interference is referred to as EMI
- Electromagnetic susceptibility is referred to as EMS
- R&S® refers to Rohde & Schwarz GmbH & Co. KG

2 Introduction

Refer to the general block diagram below on the setup for SE system according to IEEE STD 299, EN 50147-1 and MIL-STD-188-125-1. EMC32 software is used.

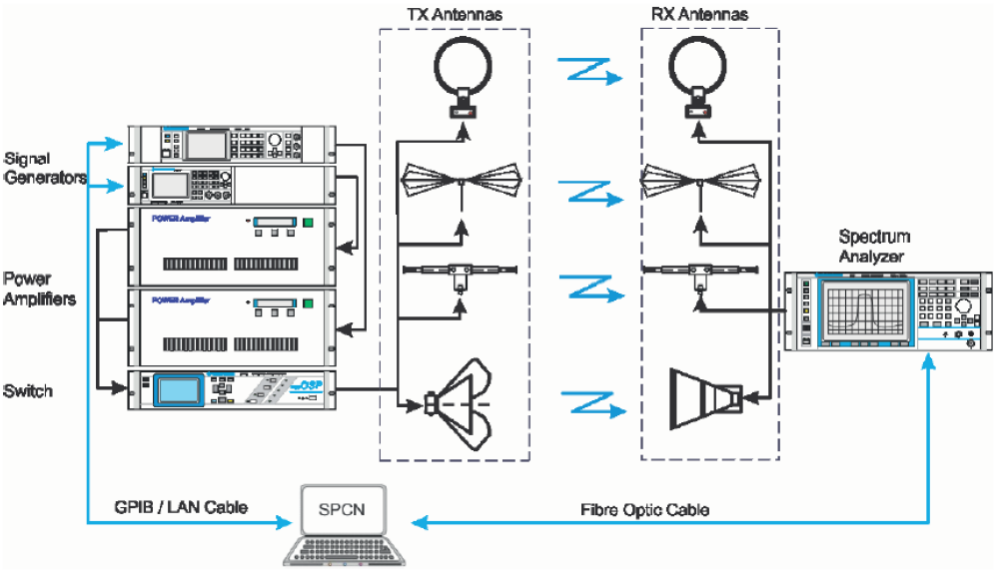


Fig. 2-1: Typical SE system

The system above consists of the following:

- RF generator as RF signal source generation
- Amplifiers to magnify signal to increase system dynamic range
- Antenna sets for transmitting and receiving
- Spectrum analyzer measuring the received level at a given level of signal source generated
- Switching unit which can be used to switch to different amplifiers of different frequency range capabilities
- Network analyzer for SE measurement of an enclosure

3 EMC32 Setup

Follow the instructions below to setup EMC32. The steps are:

- Installation of software and drivers
- iKey requirements
- Online help

3.1 Installation of Software and Drivers

This test is programmed to work with EMC32 version 9.20 and above. Follow the installation procedures below:

1. Install National Instruments GPIB driver with NI-VISA.
2. Install EMC32 version 9.20 or higher. It is important to check all options for EMI and EMS.
3. Install iKey application
4. Install VISA and drivers for relevant R&S device (e.g. SMC100A, SMF100A, NRP-USB, and FSP)

The software can now be launched.

3.1.1 EMC32 on the Web

Do check for the latest version of EMC32 via the help menu. In the main toolbar, select “?” and click on “EMC32 on the Web”. Alternatively, you may also find the latest update info at www.emc32.rohde-schwarz.com.

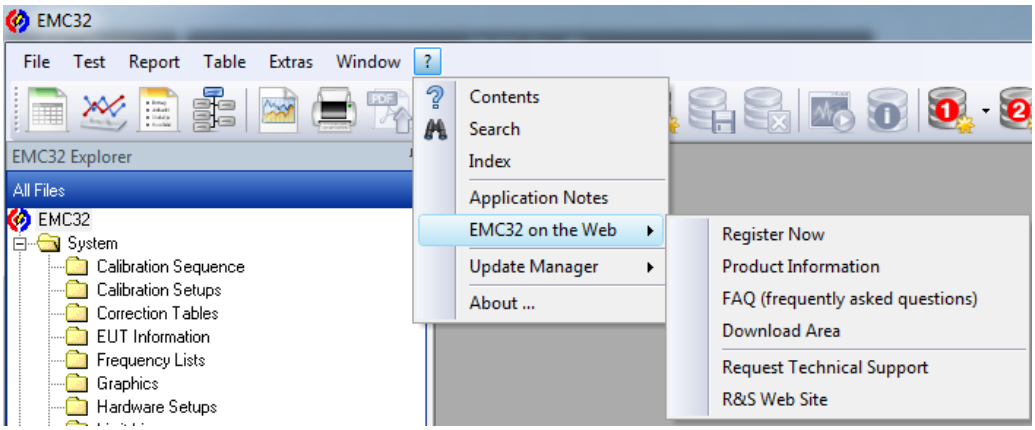


Fig. 3-1: EMC32 on the web

3.1.2 Update Manager

The EMC32 integrated update manager will automatically prompt whenever there is a new service patch or version update. You can either enable or disable this update manager via the help menu by selecting “?” and clicking on “Update Manager” for its settings.

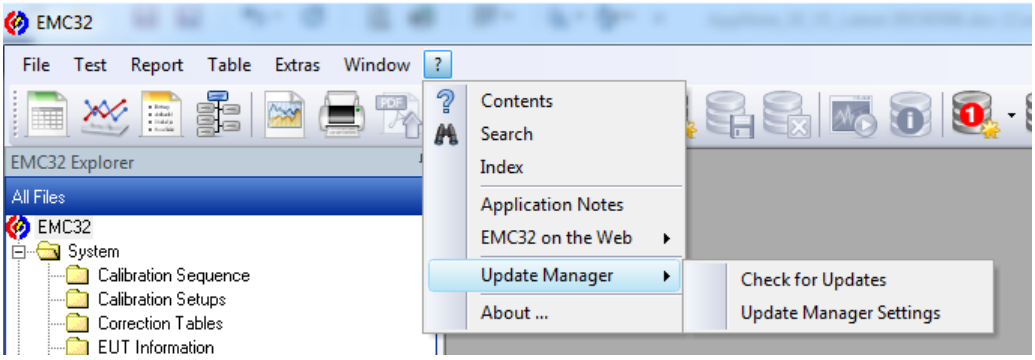


Fig. 3-2: Update manager

3.2 iKey Requirements

EMC32 uses a physical USB dongle referred to as iKey to run test simulations and control real equipment. Without the iKey, the EMC32 software can only run test simulations.

The required iKeys options for SE are EMC32-S (EMS Scan template), EMC32-K4 (EMS Auto-Test) and EMC32-K48 (Shielding Effectiveness Test). EMC32 allows merging of several options onto one iKey using EMC32 iKey Merge Tool from the EMC program group. You may refer to the EMC32 installation manual chapter 9 for more information on using the iKey Merge Tool.

3.3 Online Help

Online help is available on the CD and on the software after installation. Help can be accessed at any time via the main toolbar by selecting "?" or by pressing the **F1** key.

4 Test Configuration

Before performing SE measurements in EMC32, setup the test configuration as described in the following sections:

- Instrumentation
- Hardware Setup

4.1 Instrumentation

Refer to chapter 3.3 "Online Help" on page 6. In HTML Help, select the **Index** tab, search for "Device list" to show a detailed description on setting up the instruments.

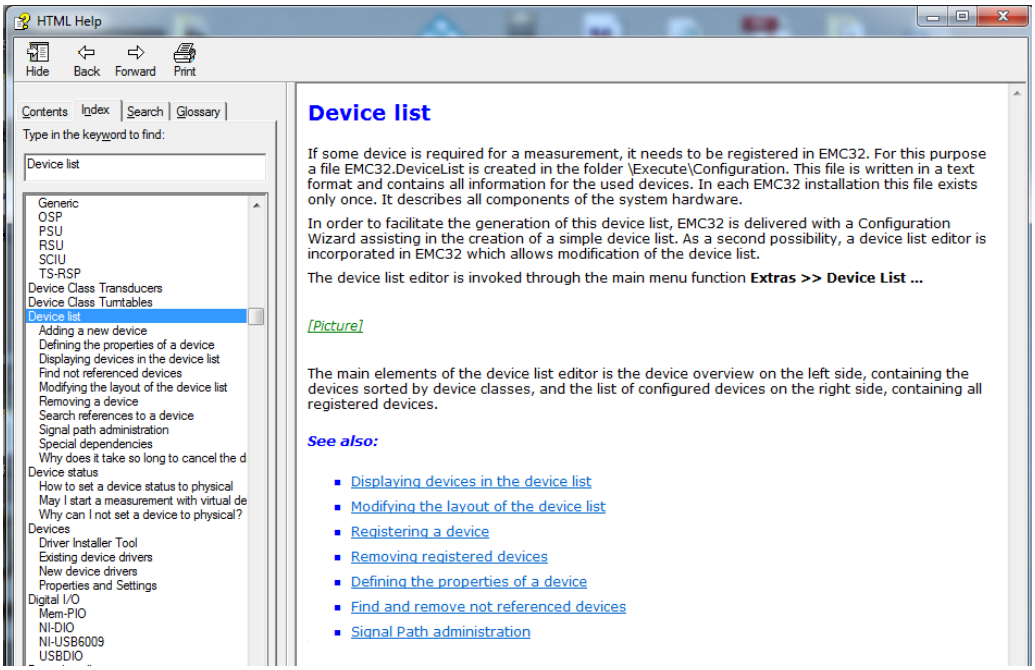


Fig. 4-1: Online help for device list

The EMC32 software supports a wide range of spectrum analyzer models, antenna mast controller, amplifiers and their interlock, and OSP switch units.

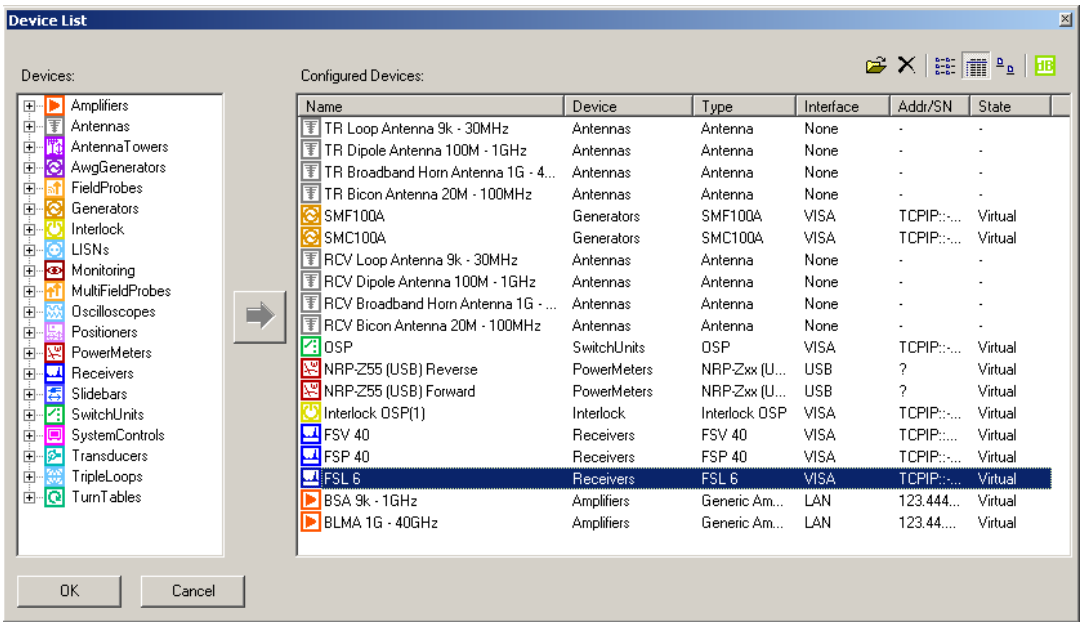


Fig. 4-2: Device list dialog box

4.2 Hardware Setup

Refer to chapter 3.3 "Online Help" on page 6. In HTML Help, select the **Index** tab, search for "Hardware Setup" to show a detailed description on setting up the hardware.

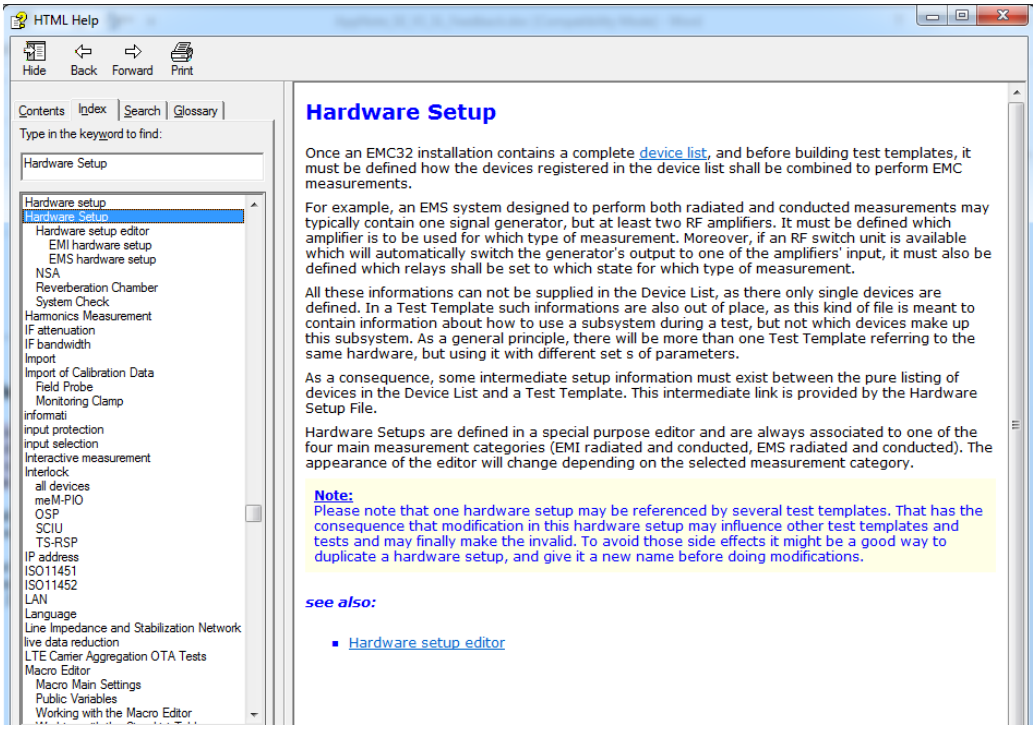


Fig. 4-3: Online help for hardware setup

Hardware setup can be configured for splitting into different frequency subranges to suit different antennas, amplifiers and generator models. It is recommended to conduct splitting according to the antenna subranges.

A typical SE system setup consist of a generator, power amplifier, power sensors, transmit antenna, receive antenna, switching unit and receiver (see chapter 2. "Introductions" on page 4). This is the same setup used in EMC32-S (Susceptibility) hardware setup for SE test.

5 Test Template Configurations

Before performing SE measurements in EMC32, setup the test template configuration as described in the following sections:

- Reference Level Test Template
- EUT Test Template
- EUT Monitoring Test Template
- EUT Auto Test Template

5.1 Reference Level Test Templates

Refer to chapter 3.3 "Online Help" on page 6. In HTML Help, select the **Index** tab, search for "EMS test new" to show a detailed description on setting up the reference level test template.

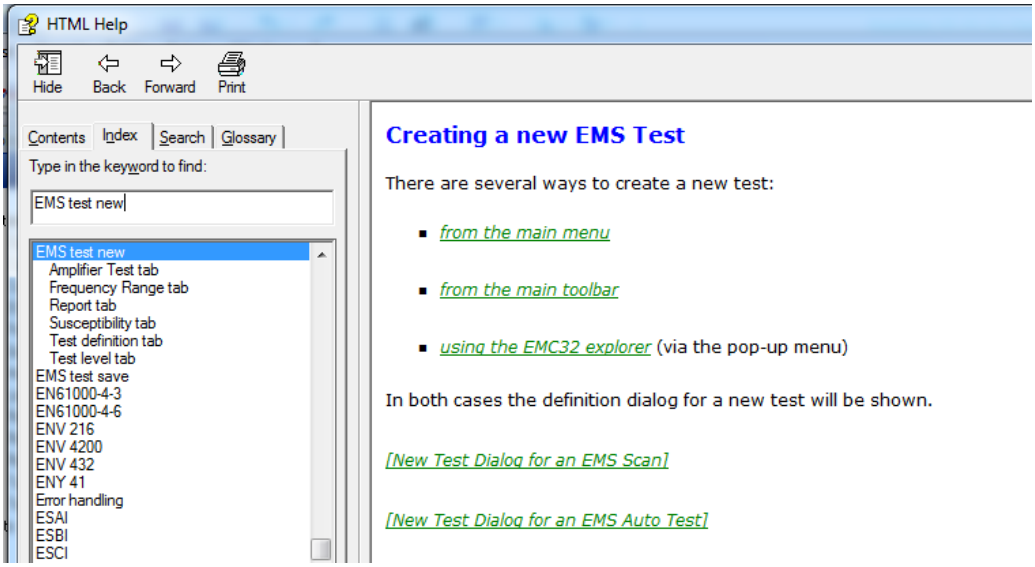


Fig. 5-1: Online help for Reference level test template

Reference level test template, known as reference calibration test template in EMC32, is required to calibrate a known level at the output of the transmit cable, and to save the result to a reference calibration table.

The purpose of reference level test for SE is to set a reference for generator level to achieve SE maximum RF level which is known as reference calibration in EMC32.

This template is used for the first calibration without EUT. The test template is configured with several sub-ranges according to the different antennas and also the antenna sub-ranges.

In EMC32, reference level test is created in EMS scan test template in order to select the correct hardware setup and run as reference calibration test method to perform reference level testing.

5.1.1 Reference Level Test Template for SE

This chapter includes some of the parameters that is needed for the reference level test templates (known as reference calibration in EMC32) to perform the SE test.

For SE reference level measurement, SE test standard will be created in the EMC Test Standard dropdown box. EMC32-K48 option will be needed to activate the SE test standard

In Fig. 5-2, select **General Settings** tab. Under **EMC Test Standard**, select "SE REF CAL" from the dropdown list.

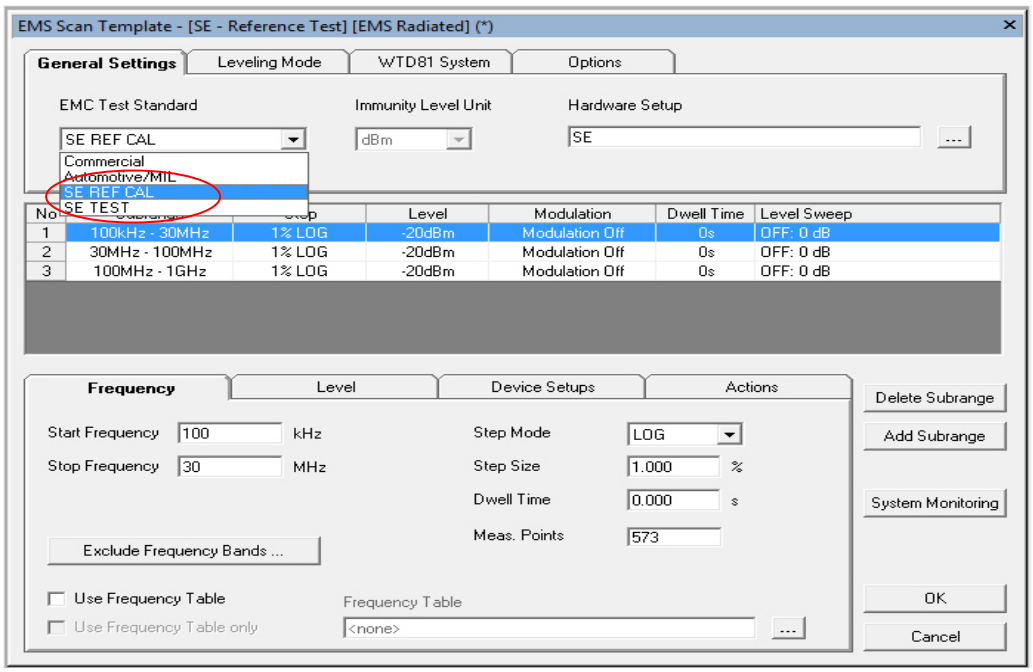


Fig. 5-2: Test standard selection for SE

In Fig. 5-3, select **Frequency** tab. In the area **Start Frequency** and **Stop Frequency**, enter the appropriate antenna frequency subranges.

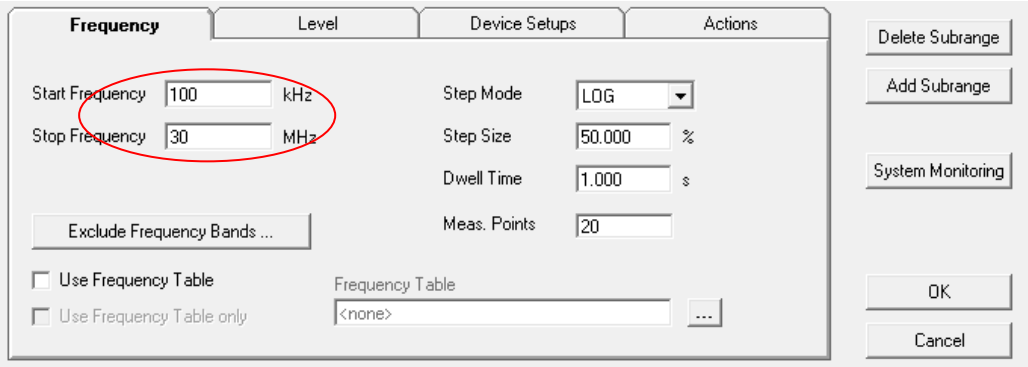


Fig. 5-3: Antenna frequency subranges setting

In Fig. 5-4, select **Leveling Mode** Tab. Under the section **Common Ref. Cal. File Name**, enter desired filename in the field below.

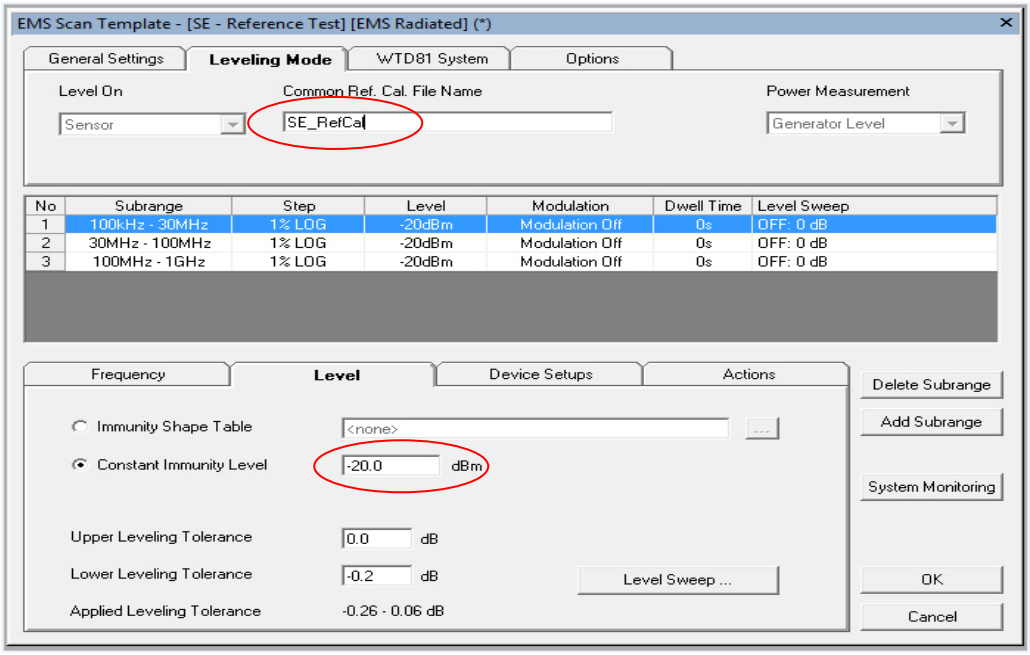


Fig. 5-4: Filename entry

From Fig. 5-5, select **Device Setups** tab. Click "Span" to bring up the dialog box as shown in Fig. 4-4. Set **Device Mode** to "Receiver" to activate zero span measurement and **Detector** to "Average".

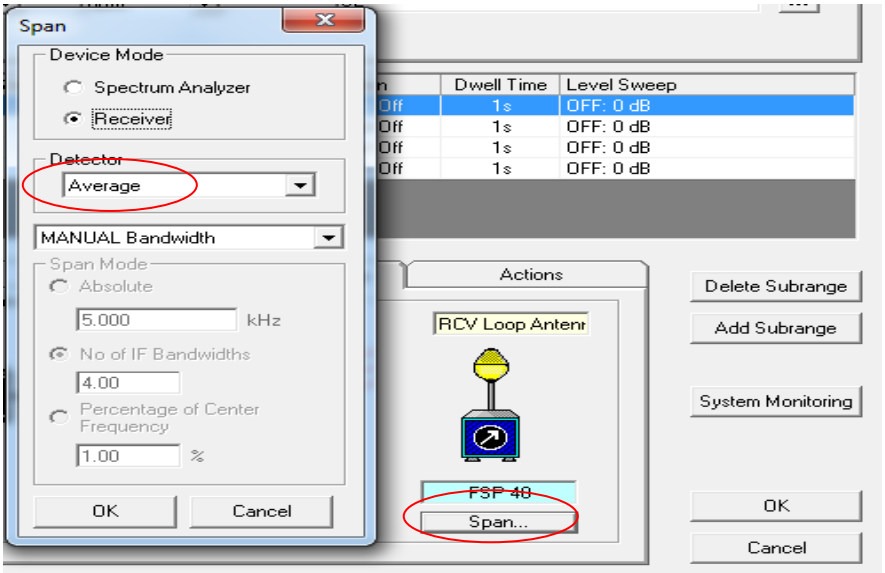


Fig. 5-5: Span dialog box

5.2 EUT Test Template

Refer to chapter 3.3 "Online Help" on page 6. In HTML Help, select the **Index** tab, search for "EMS test new" to show a detailed description on setting up the EUT test template.

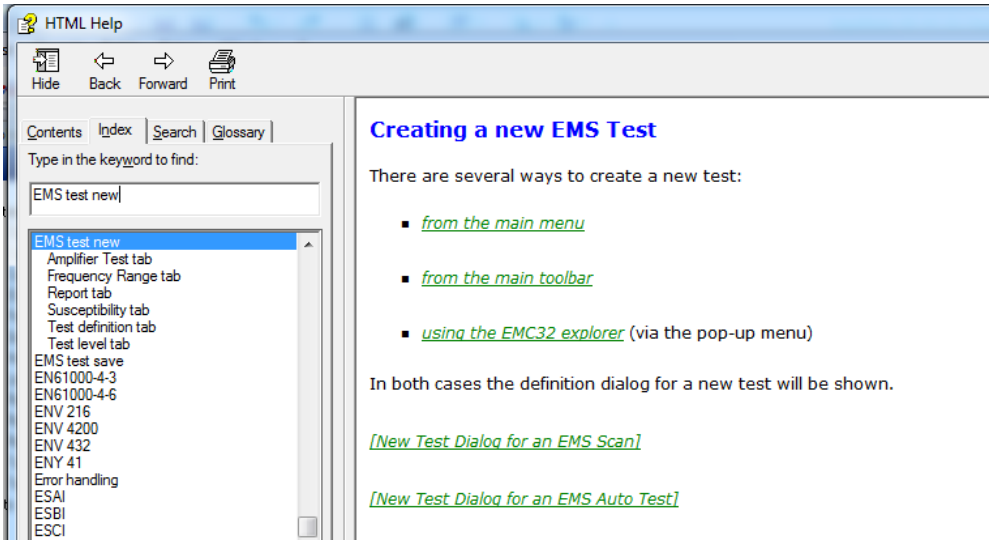


Fig. 5-6: Online help for creating a new EMS test

This template is used for measurement on the actual EUT. It sets the output transmit level according to previous reference level results and measure the difference in the output level from within the EUT. This difference is the shielding effectiveness.

The hardware setup should be preset accordingly (see chapter 4.2 "Hardware Setup on page 9) before the EUT test sequence can be created in the EMS scan test template. The EUT test carries out the antenna coupling test using the substitution method, based on the saved reference calibration table.

5.2.1 EUT Test Template for SE

For SE test configuration, SE test standard will be created in the EMC Test Standard dropdown box. EMC32-K48 option will be needed to activate the SE test standard

In Fig. 5-7, select **General Settings** tab. Under **EMC Test Standard**, select "SE TEST" from the dropdown list.

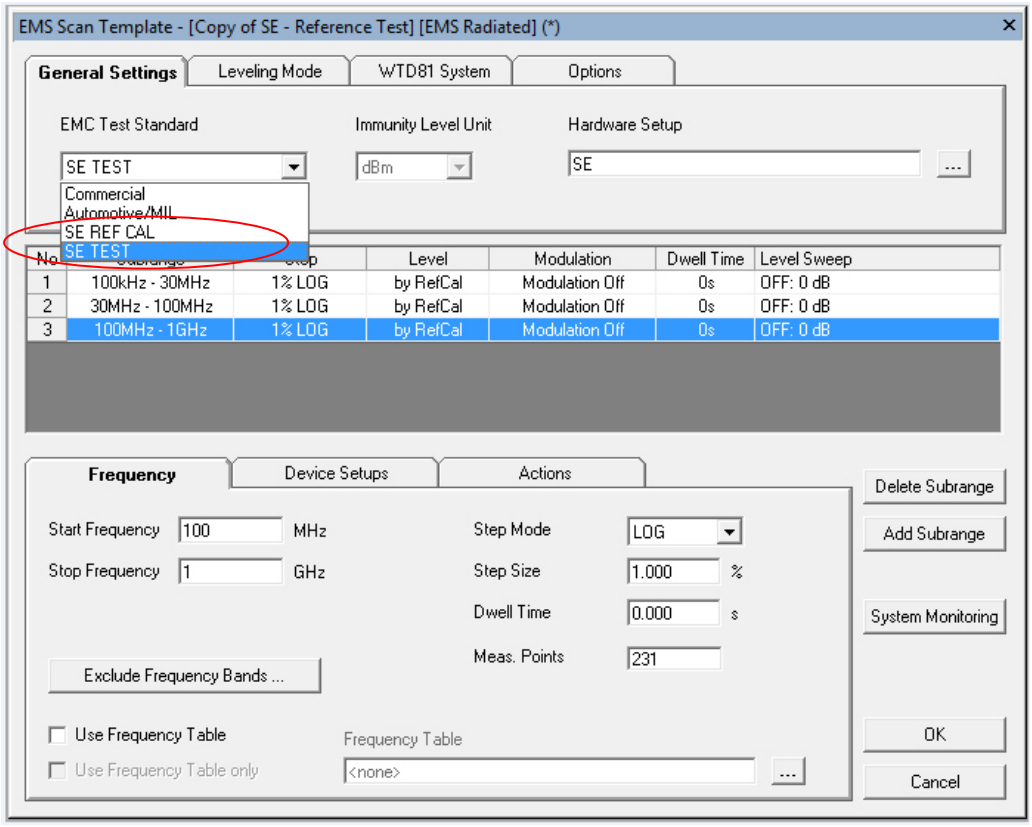


Fig. 5-7: SE test standard selection

For SE requirement, (nominal) immunity level in test measurement should follow its reference level table to maintain a nearly fixed generator level output for both horizontal and vertical polarization.

In Fig. 5-8, select **Leveling Mode** tab, input any reference calibration table created in SE REF CAL test template. Target level generator output will follow its reference calibration generator output hence the Power Control dropdown box will be greyed out.

Take note that SE tests are not run via a normal EMS Scan Test but in EMS Auto Test.

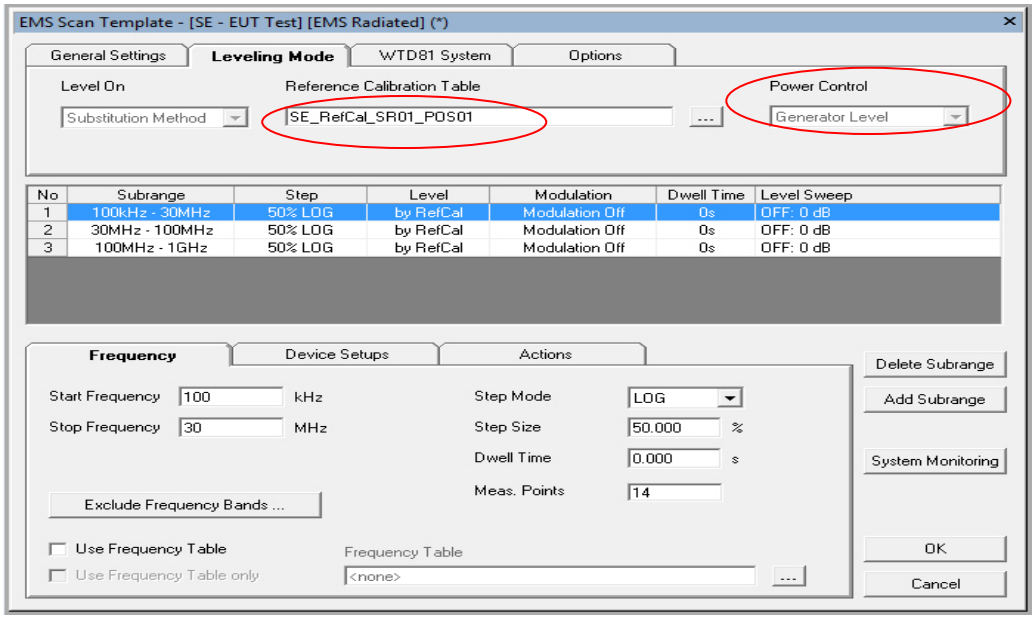


Fig. 5-8: Reference calibration table selection

5.3 EUT Monitoring Template

Refer to chapter 3.3 "Online Help" on page 6. In HTML Help, select the **Index** tab, search for "EUT Monitoring" to show a detailed description on setting up the EUT Monitoring template.

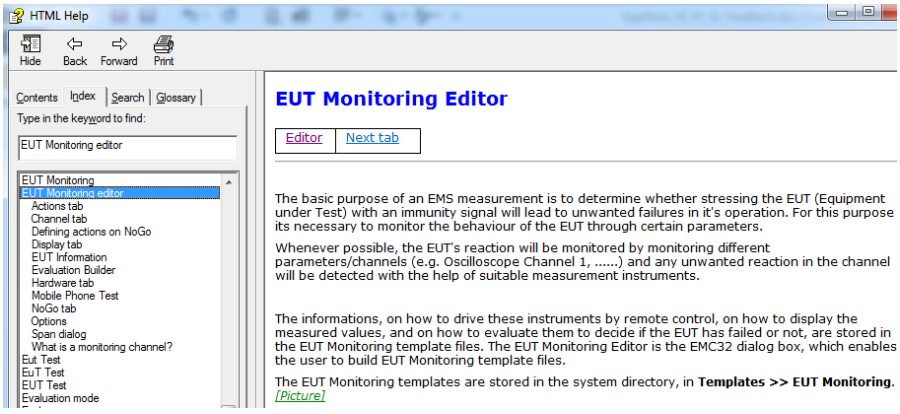


Fig. 5-9: Online help for EUT monitoring

The main purpose of a EUT measurement is to arrest unwanted failures during operation by stressing the EUT with a signal. For this purpose, the EUT monitoring template is necessary to ensure that certain parameters of the EUT are under stress still behaving as usual. It can also provide the EUT's worst-case results.

5.3.1 EUT Monitoring Template for SE

The settings of each EUT monitoring channel that use the spectrum analyzer are configured as follow:

In Fig. 5-10, select **Display** tab and set the **Units to be displayed** as "dB". Under the section **Value Conversion**, enter the evaluation formula as:

IMMLVL{Imm Lvl dB}-107-MEASVAL{Meas Value}

This is to convert the measured value in dBm and tabulate the effective results in dB.

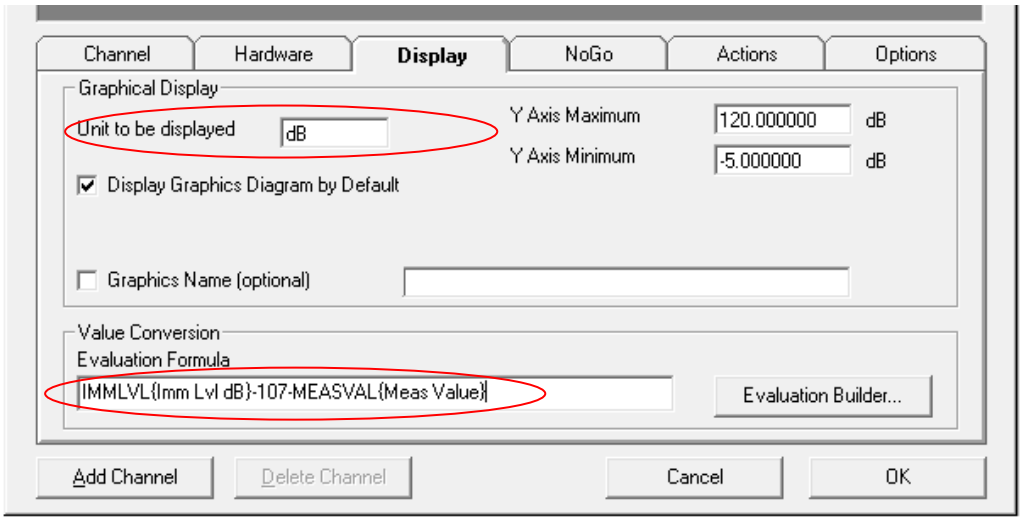


Fig. 5-10: Evaluation formula for value conversion

In Fig. 5-11, select **Options** tab. Under **EMS Auto Test Evaluation**, select checkbox option "Worst Case Analysis. Under **Evaluation Mode**, select "Max. Peak".

Fig. 5-11: EMS auto test evaluation options

5.3.2 Average Detector for EUT Monitoring

For SE testing, select "Average Detector" as shown in Fig. 5-12, instead of "Max Peak Detection". This option should be selected regardless of whether spectrum analyzer, or test receiver is used. This option is only available with EMC32-K48.

In Fig. 5-12, select **Hardware** tab. Under **Detector**, select from dropdown list "**Average**".

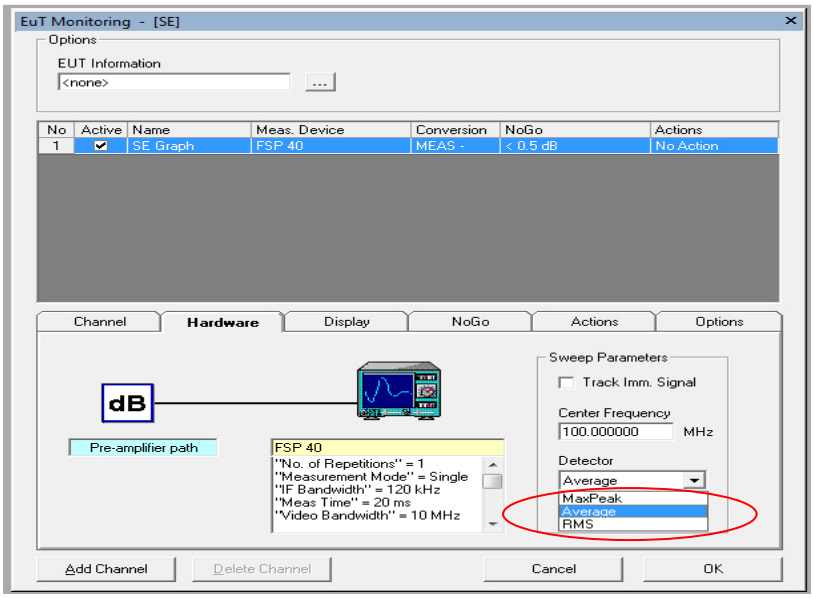


Fig. 5-12: Hardware tab in EUT monitoring window

5.3.3 Limit Line Input for EUT Monitoring

In EMC32, the NoGo in EUT monitoring defines the limit line for SE. The value of the limit line must be input in the NoGo tab as shown in Fig. 5-13. The value can either be a constant value (e.g. 120 dB), or a shape table which consists of different values at different frequencies.

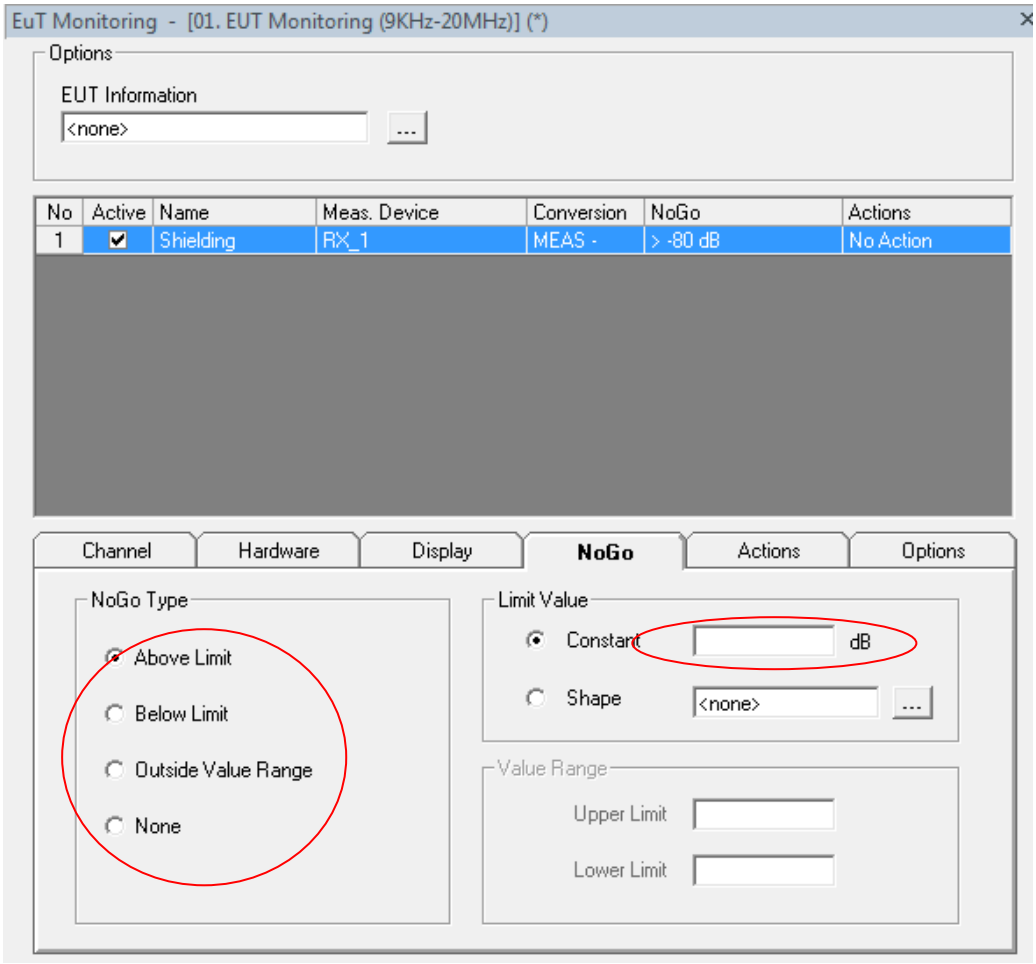


Fig. 5-13: NoGo tab in EUT Monitoring window

In the NoGo tab, the criteria for pass or fail are defined, with four NoGo types to choose from:

- **Above Limit**: The EUT has failed if the measured (and converted) value is bigger than a limit value or the value from a limit shape to be defined by the user. This type will be the preferred setting for SE measurement
- **Below Limit:** The EUT has failed if the measured (and converted) value is smaller than a limit value or the value from a limit shape to be defined by the user.
- **Outside Value Range**: The EUT has failed if the measured (and converted) value is outside of a window of values to be defined by the user.

- **None:** The EUT will never be considered to have failed, the channel is only used for recording the EUT's parameter.

The limits defined here will be displayed in the graphics window associated to the channel.

5.4 EUT Auto Test Template

Refer to chapter 3.3 "Online Help" on page 6. In HTML Help, select the **Index** tab, search for "EMS Auto Test Template Editor" section to show a detailed description on setting up the EUT Auto Test template.

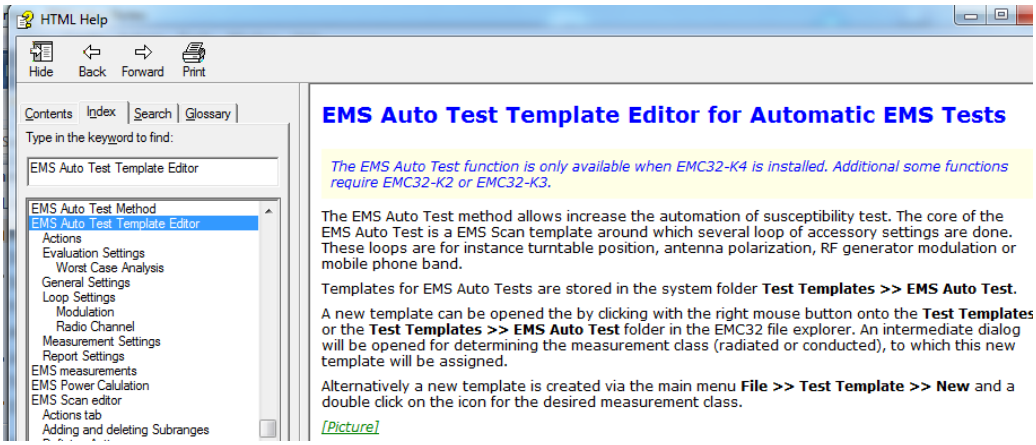


Fig. 5-14: Online help for EMS auto test template editor

EUT auto test (known as EMS auto test in EMC32), further enhances the automation capability of SE test. It allow users to repeat frequency sweeping of EUT measurement for multiple location, multiple subranges and different polarization when EMC32-K48 option is used. In addition, EUT monitoring template can be used together with EUT auto test to calculate SE for each location. Worst case analysis feature is also available to obtain the worst case result over all locations for every frequency point.

5.4.1 EUT Auto Test for SE

This section shows the configuration for EUT Auto Test for SE Test.

From Fig. 5-15, left-click on **Measurement Settings**. Enter the same setup as the EMS Scan template for EUT test.

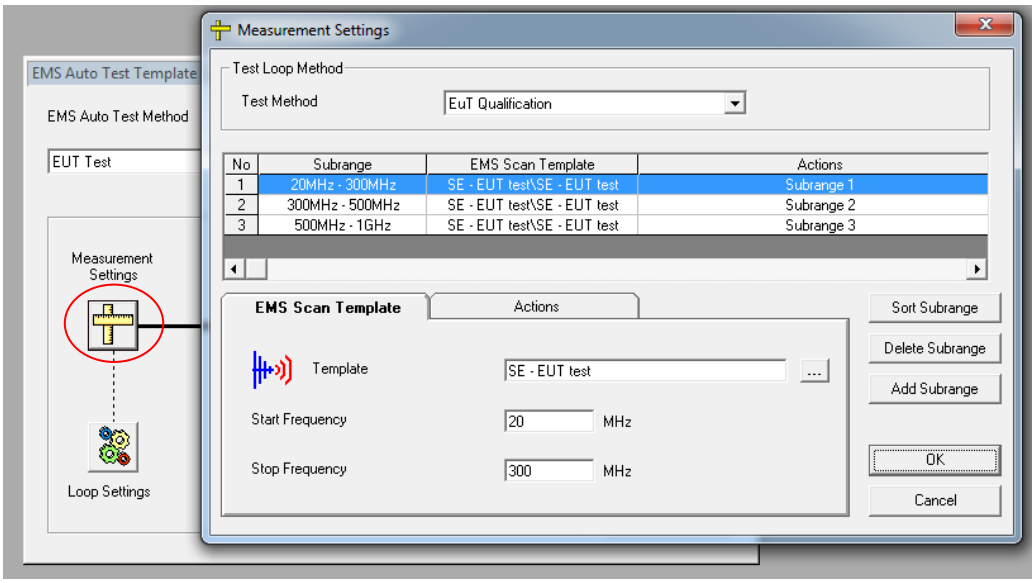


Fig. 5-15: Measurement settings for EUT auto test

From Fig. 5-16 left-click on **Loop Settings**, add polarization and auto test subranges.

Under **User Definition Loop Settings**, enter the number of antenna positions. The step number corresponds to the antenna position number. For example, step 1 refers to antenna position 1.

Select checkbox **Visible Column in the Report** to display each loop column in the test report. Select checkbox **Show Trace for each Loop Result** to show loop result graphics in the test report.

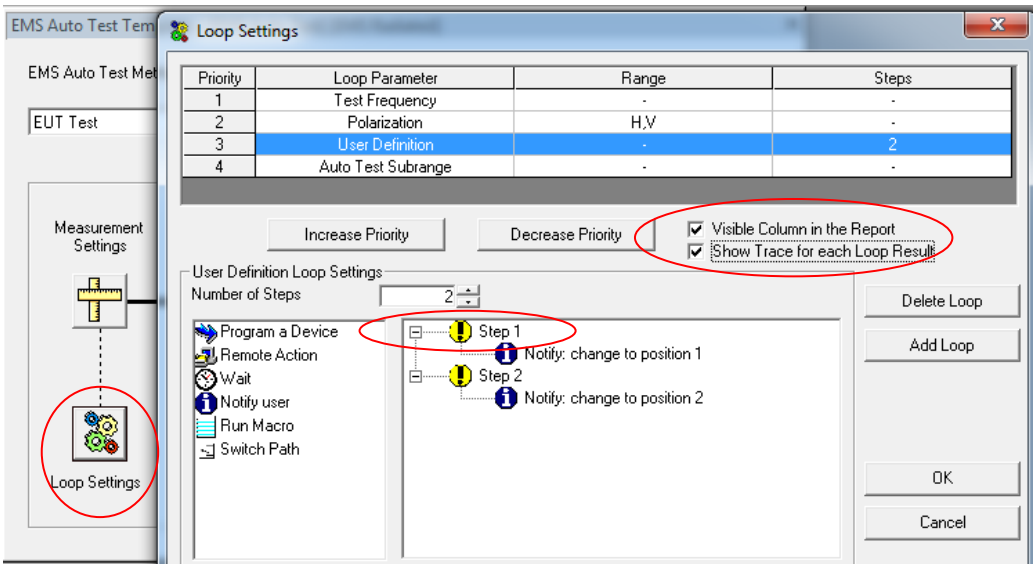


Fig. 5-16: Loop settings for EUT auto test

From Fig. 5-17, left-click on **Evaluation Settings** to show its dialog box. Under **EUT Worst Case Analysis**, select checkbox for "Do Worst Case Analysis for EUT Monitoring Channels".

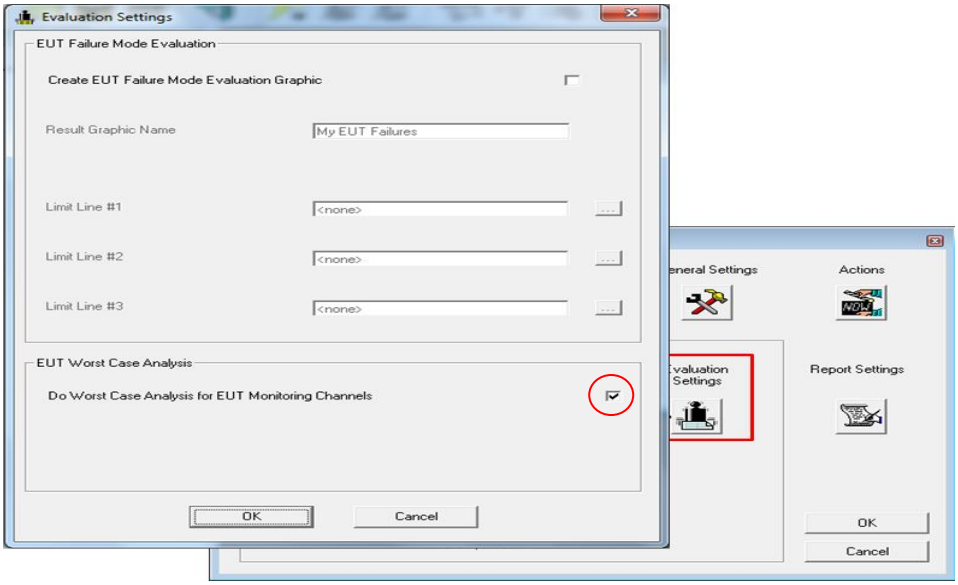


Fig. 5-17: Evaluation settings for EUT auto test

From Fig. 5-18, left-click on **General Settings** to open its dialog box. Set the "EUT Monitoring" file to be used.

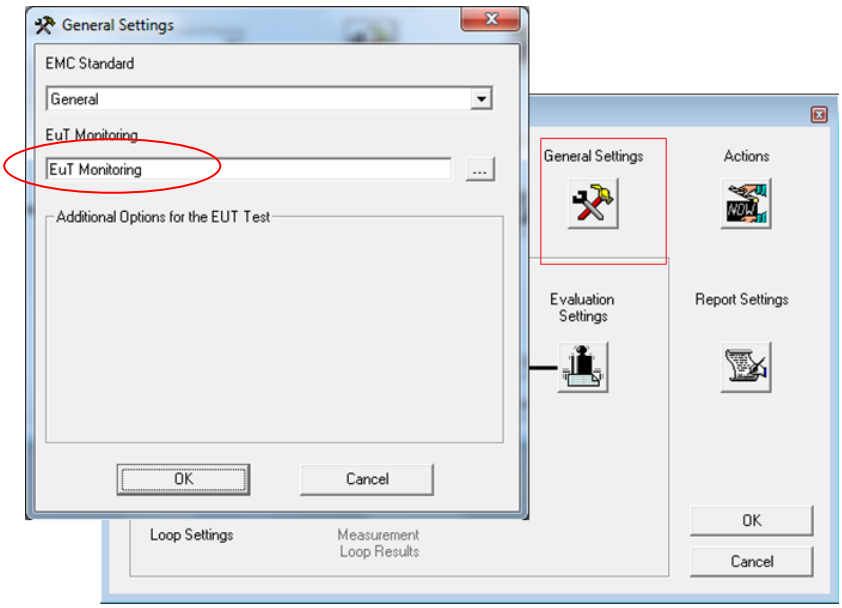


Fig. 5-18: General settings for EUT auto test

6 Running of Test

6.1 Reference Level Test for SE

The objective of a reference calibration is to set a **known calibrated level** at the **connection point** to the **transmitting antenna**. This calibrated level will then be used again with the EUT to get the SE of the shielded enclosure.

As shown in Fig. 6-1 below, the output cable is directly connected to the transmitting antenna; and the receiving antenna output cable is directly connected to the spectrum analyzer. The minimum respective distances between the transmitting antenna and receiving antenna are 0.6 m at 9 kHz to 20 MHz, 2 m at 20 MHz to 1 GHz and 1 m above 1 GHz.

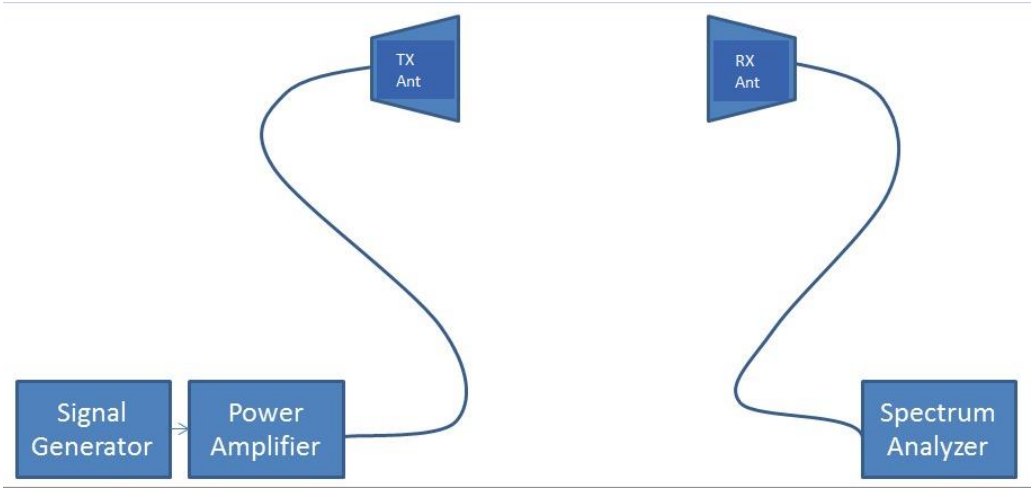


Fig. 6-1: Reference level test for SE

Under **Test Template > EMS Scan > SE - Reference calibration**, right-click on the appropriate reference calibration template and select "New Test".

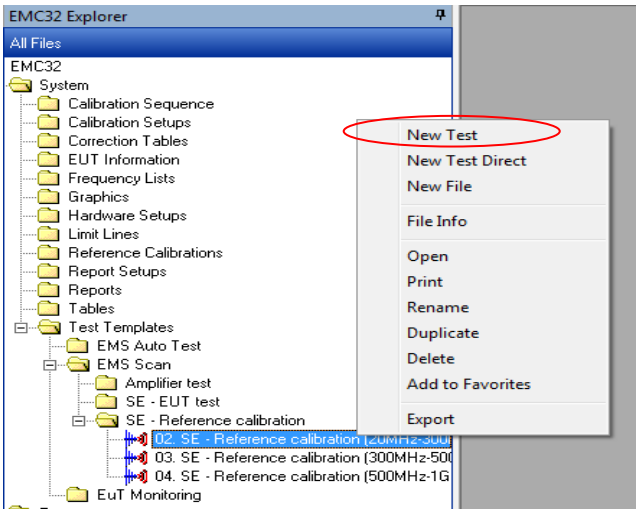


Fig. 6-2: New test selection

In Fig. 6-3, select **Test Definition** tab. Under **Test method**, select "Reference Calibration" from the dropdown list and click OK.

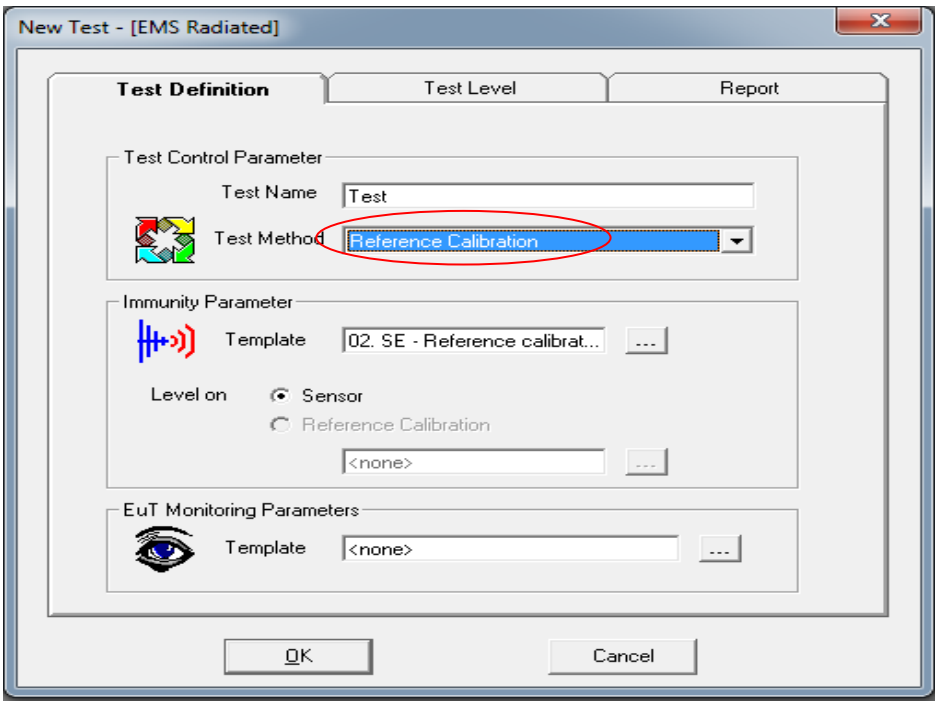


Fig. 6-3: Test method selection

In Fig. 6-4, click play/start button to begin the reference calibration.

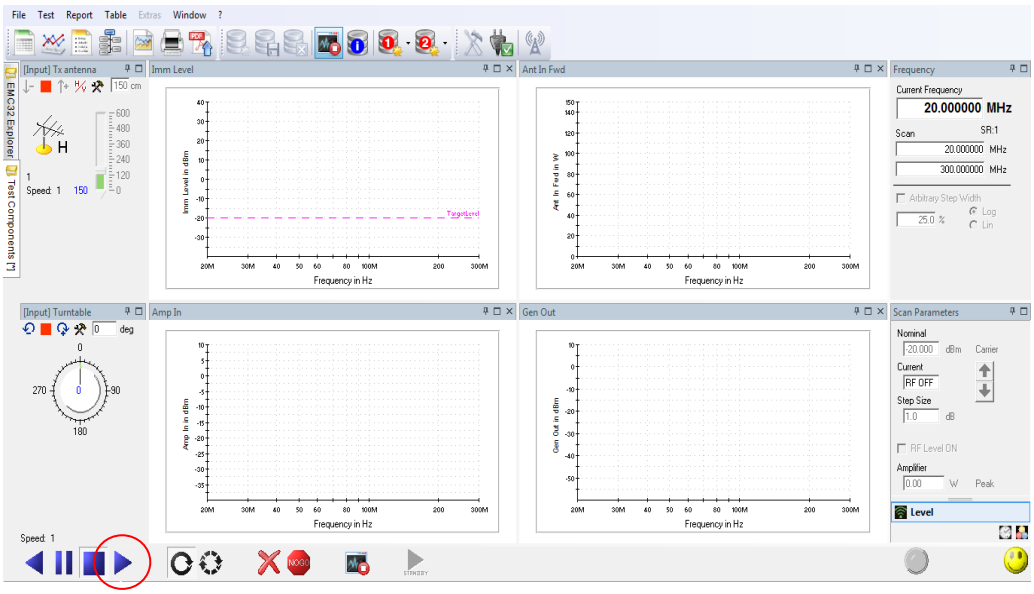


Fig. 6-4: Reference level test

A prompt window message will appear to announce completion of the reference calibration process. If multiple frequency subranges were inputted in the calibration, a prompt window as shown in Fig. 6-5 will appear. Choose the corresponding antenna position for the subrange that will be measured.

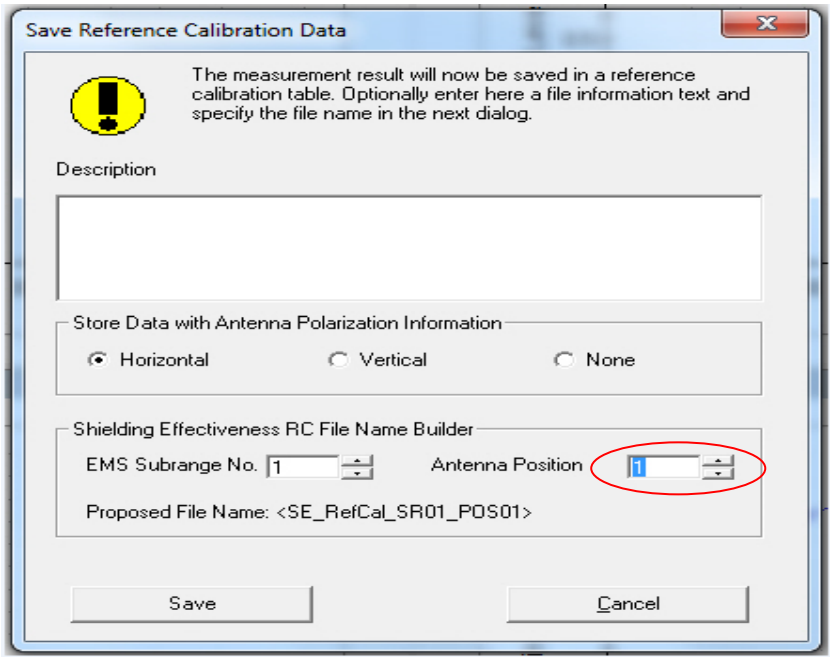


Fig. 6-5: Reference calibration data

The naming convention for saving the reference calibration table will be SE_RC_Name_SR0x_POS0y; where SE_RC_Name is the reference calibration name, x is the subrange number and y is the antenna position.

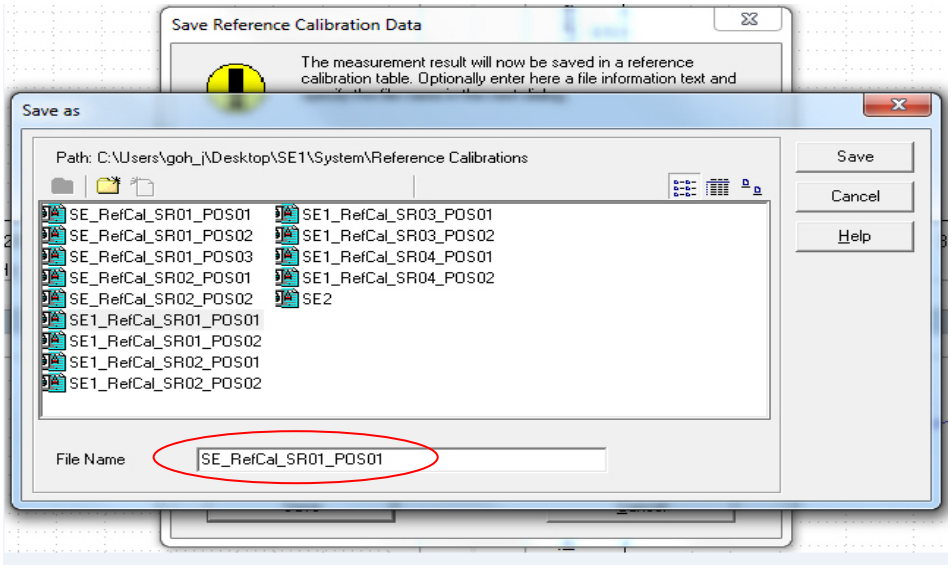


Fig. 6-6: Reference calibration filename convention

Save desired reference calibration for all subranges and antenna positions that are to be tested. Commence with the EUT testing. With the calibration results, the EUT test can now begin.

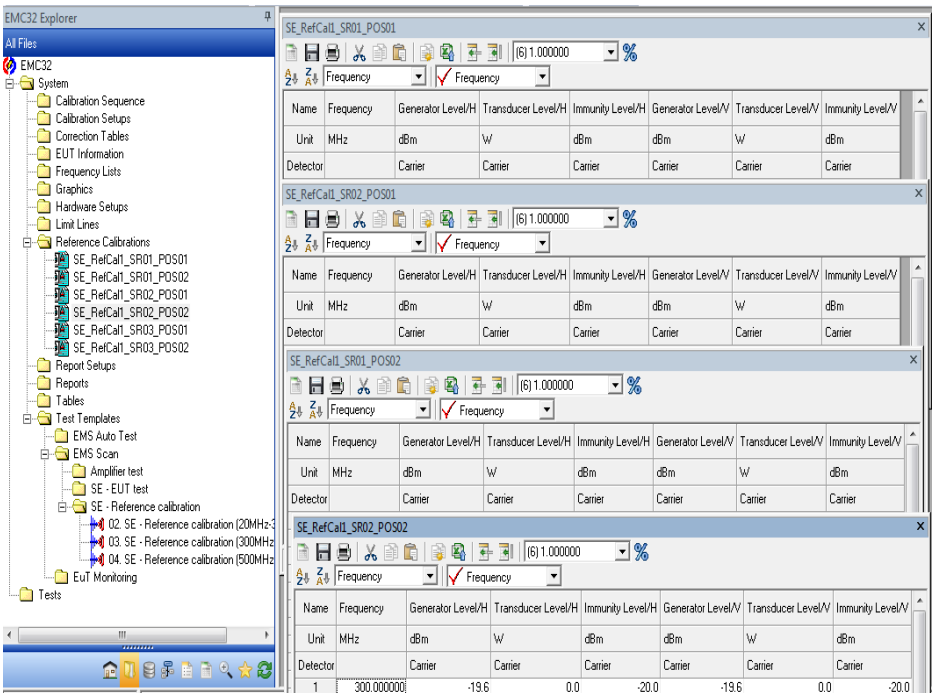


Fig. 6-7: Reference calibration result parameters

6.2 EUT Auto Test for SE

The receiving antenna is placed inside the EUT to be measured. Using EMC32, run the Auto Test template as described in the actions that follows.

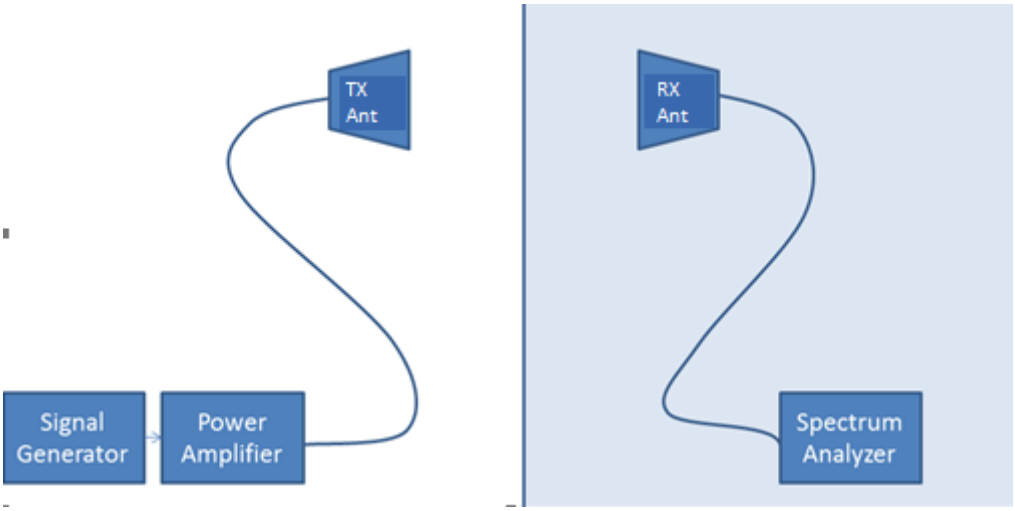


Fig. 6-8: EUT test for SE

Under **Test Template > EMS Auto Test**, right-click on the appropriate test template and select "New Test".

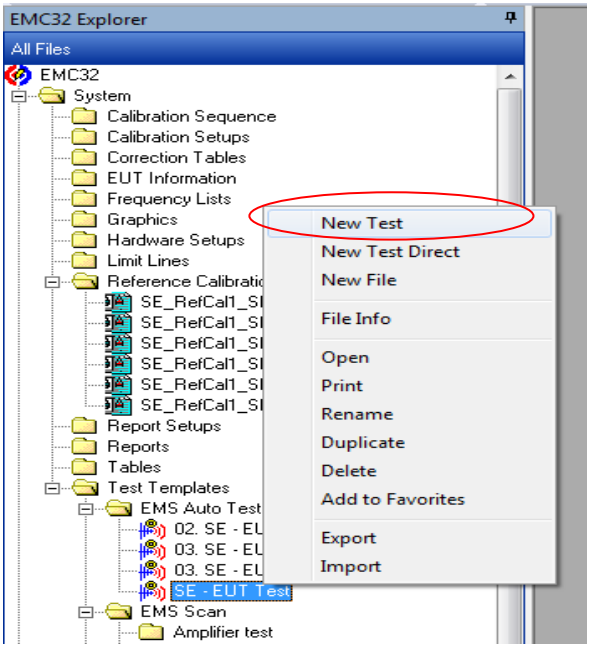


Fig. 6-9: New test selection

In Fig. 6-10, select **Test Definition** tab. Under **Test method**, select "EMS Auto Test" from the dropdown list. Under **EUT Monitoring Parameters**, select the appropriate EUT monitoring file and click OK.

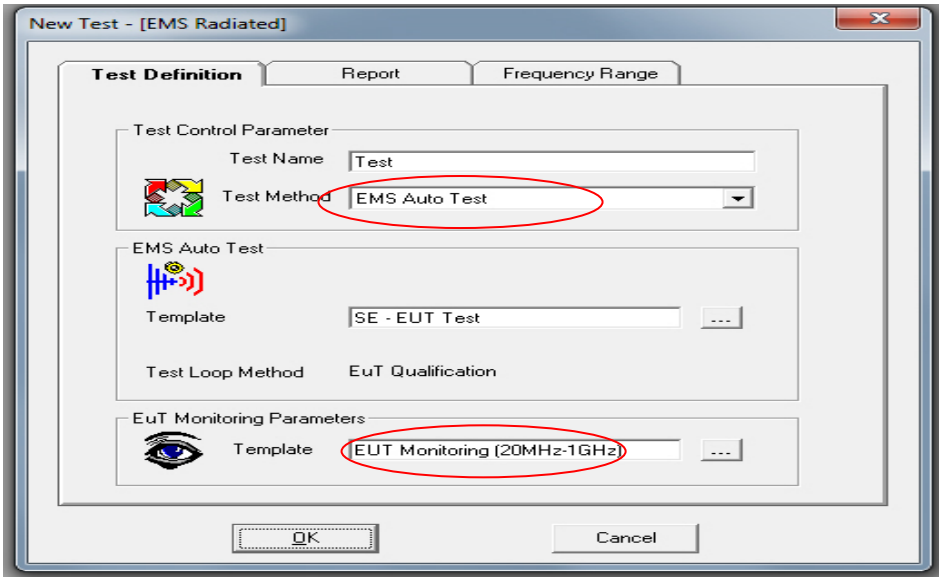


Fig. 6-10: Test method selection

In Fig. 6-11, click play/start button to begin the EMS Auto Test for SE.

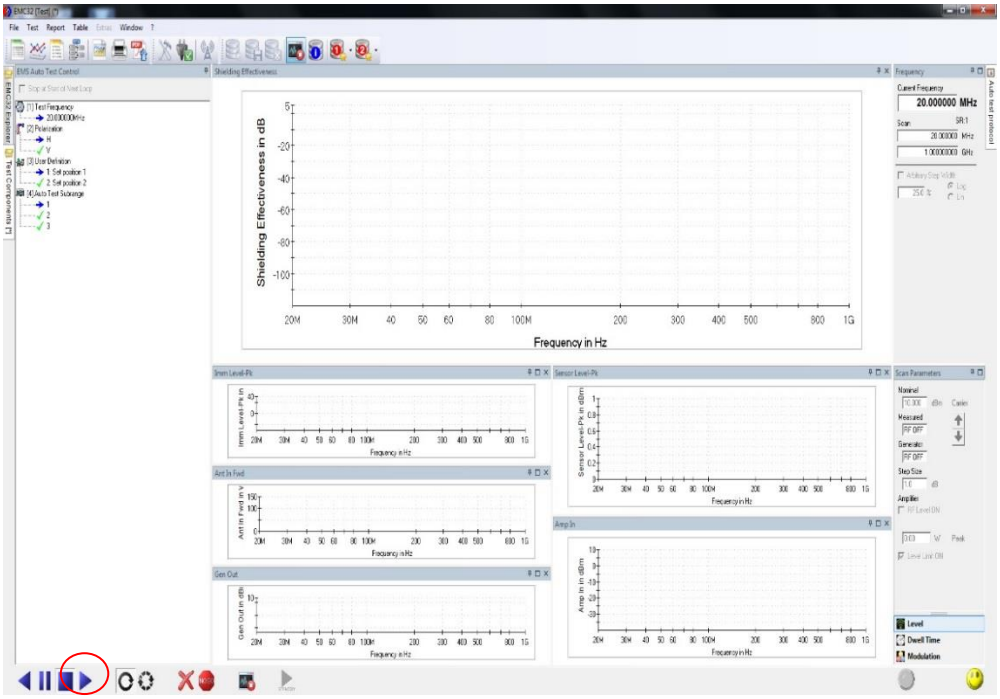


Fig. 6-11: EUT auto test

In the left window toolbox under **User Definition**, right-click the corresponding set position. Select **Set as next Loop Position** to move to the next frequency range or polarization.

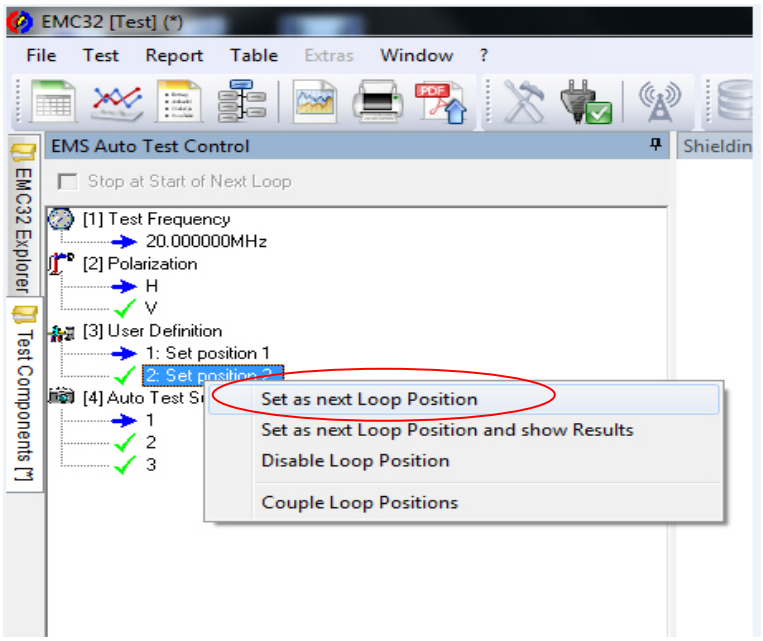


Fig. 6-12: Next loop position

The worst case analysis will be reflected when EUT Monitoring Template is used with EMS Auto Test.

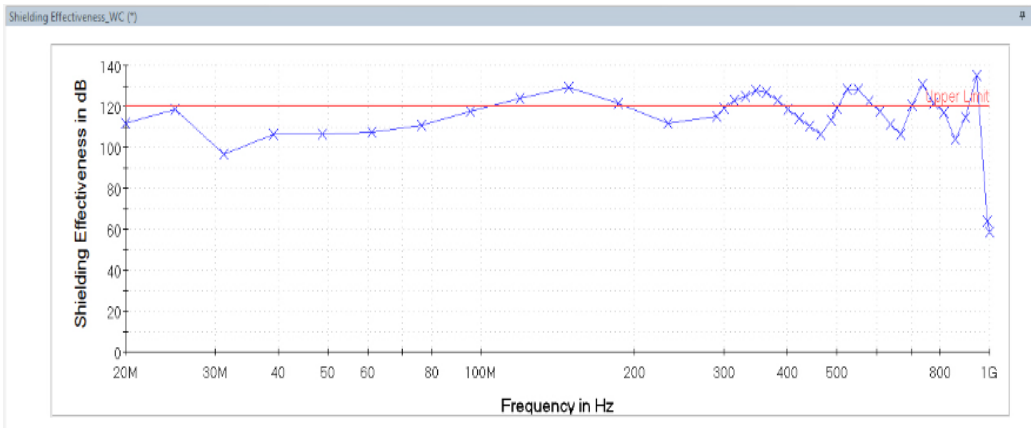
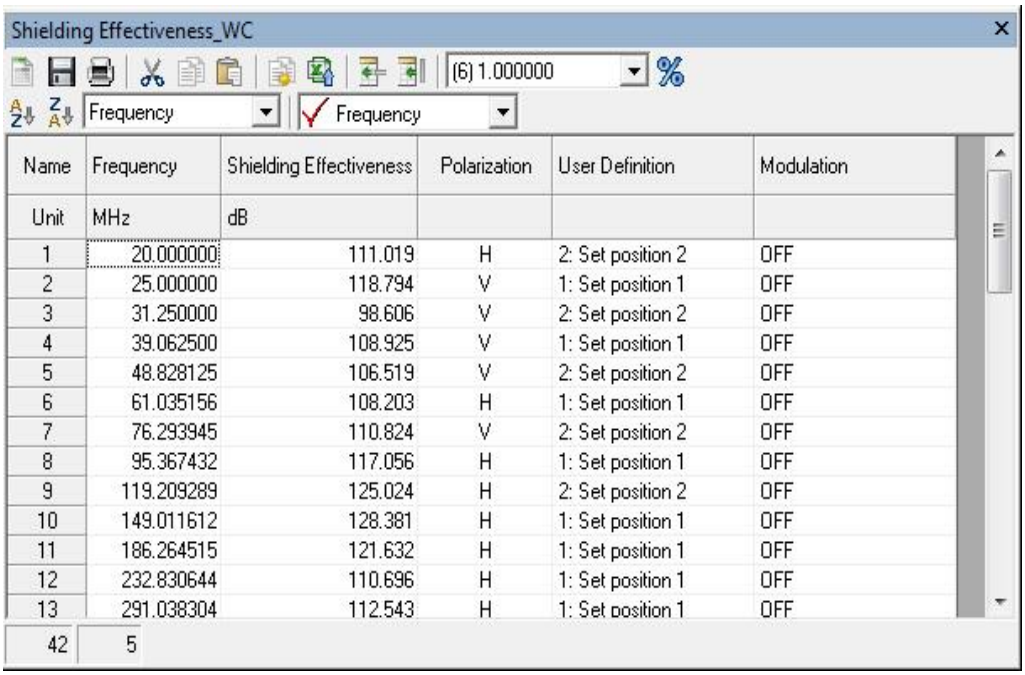


Fig. 6-13: Worst case analysis

The results are also made available in table format.



Name	Frequency	Shielding Effectiveness	Polarization	User Definition	Modulation
Unit	MHz	dB			
1	20.000000	111.019	H	2: Set position 2	OFF
2	25.000000	118.794	V	1: Set position 1	OFF
3	31.250000	98.606	V	2: Set position 2	OFF
4	39.062500	108.925	V	1: Set position 1	OFF
5	48.828125	106.519	V	2: Set position 2	OFF
6	61.035156	108.203	H	1: Set position 1	OFF
7	76.293945	110.824	V	2: Set position 2	OFF
8	95.367432	117.056	H	1: Set position 1	OFF
9	119.209289	125.024	H	2: Set position 2	OFF
10	149.011612	128.381	H	1: Set position 1	OFF
11	186.264515	121.632	H	1: Set position 1	OFF
12	232.830644	110.696	H	1: Set position 1	OFF
13	291.038304	112.543	H	1: Set position 1	OFF
42	5				

Fig. 6-14: Worst case result in table format

7 Printing Report

Refer to chapter 3.3 "Online Help" on page 6. In HTML Help, select the **Index** tab, search for "Report" to show a detailed description on setting up the Report template and print it out.

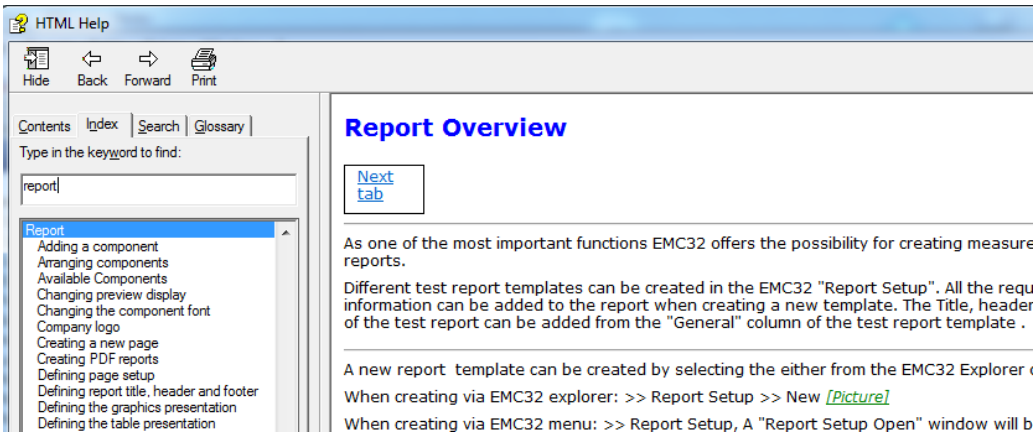


Fig. 7-1: Online help for report overview

7.1 Printing Report for SE

This section provides a guide to setting up and saving a report for SE.

When the test is complete, click on "Finish the Measurement"  to exit measurement mode.

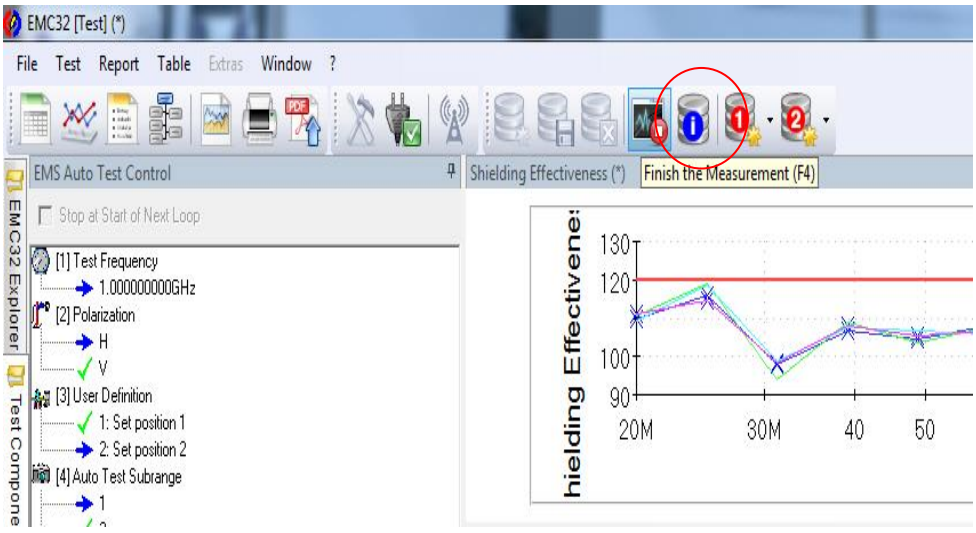


Fig. 7-2: Measurement mode exit

From the “Test Components” tab, right-click on the folder “Report Setups” and select “Add Report Setup”.

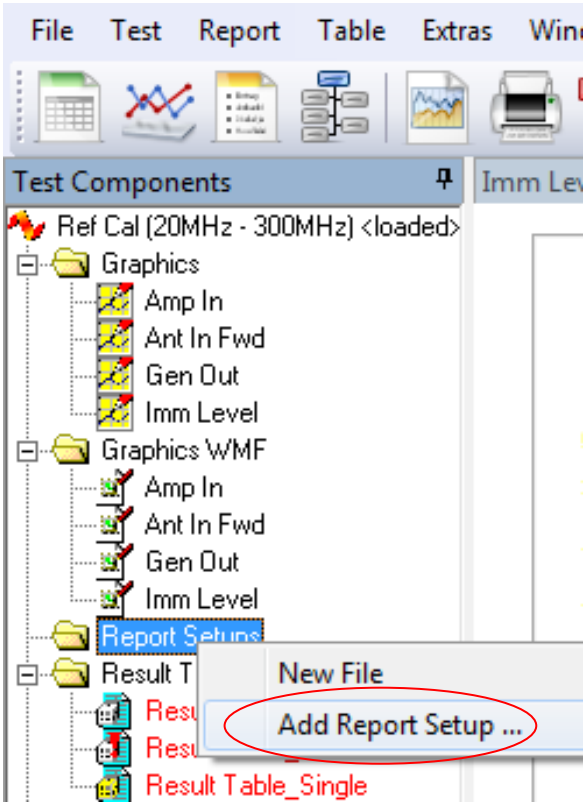


Fig. 7-3: Report setup

Select the appropriate report template and click OK

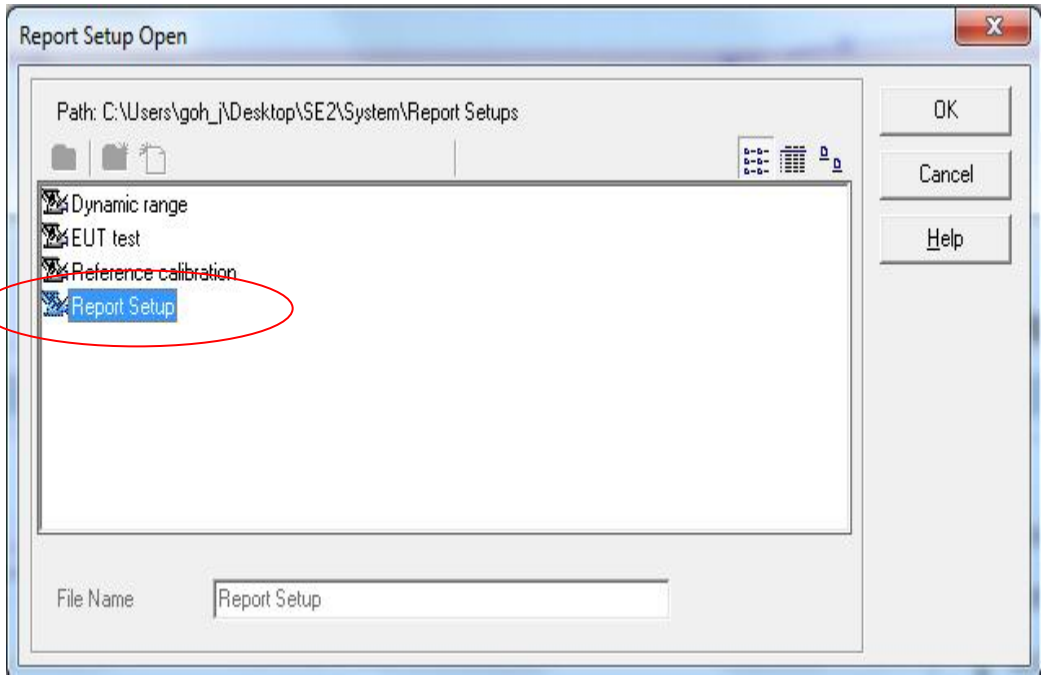


Fig. 7-4: Report template selection

The new setup will be shown in the folder "Report Setups" (see Fig. 7-5).

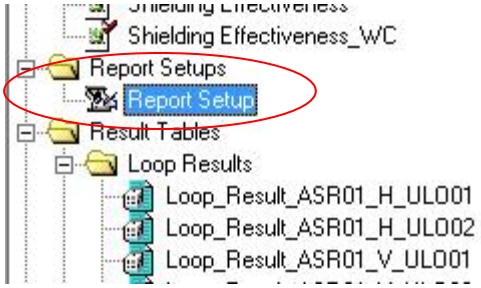


Fig. 7-5: Report setup creation

From Fig. 7-6, double-click the designated report filename for more details.

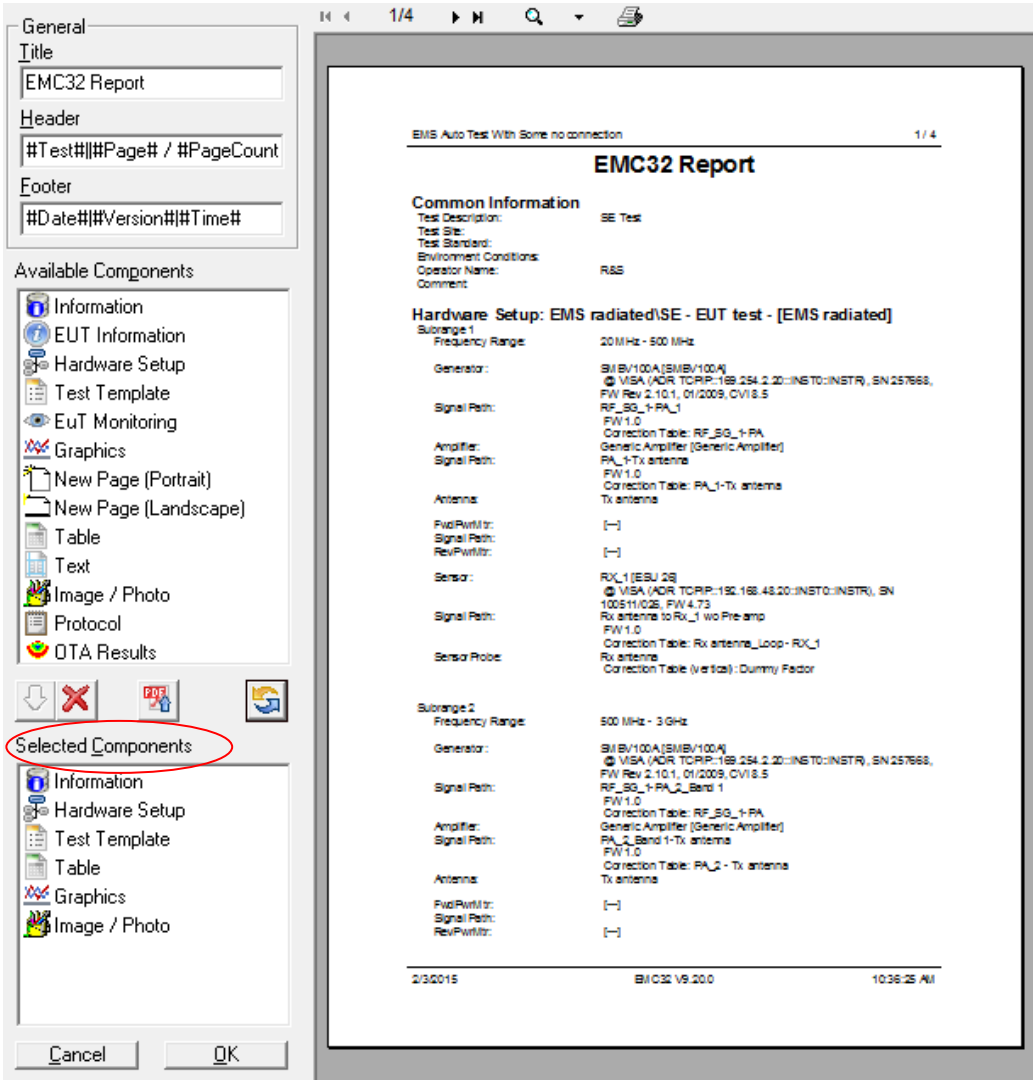


Fig. 7-6: Report details

In the left window toolbar under **Selected Components** (Fig. 7-6), double-click on "Information"  to enter the test report information description.

Fig. 7-7: Information details

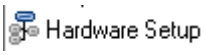
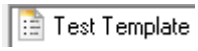
In the left window toolbar under **Selected Components** (Fig. 7-6), double-click on "Hardware Setup"  to select the hardware setup required in the report.

Fig. 7-8: Hardware setup option

In the left window toolbar under **Selected Components** (Fig. 7-6), double-click on "Test Template"  to select the test template required in the report.

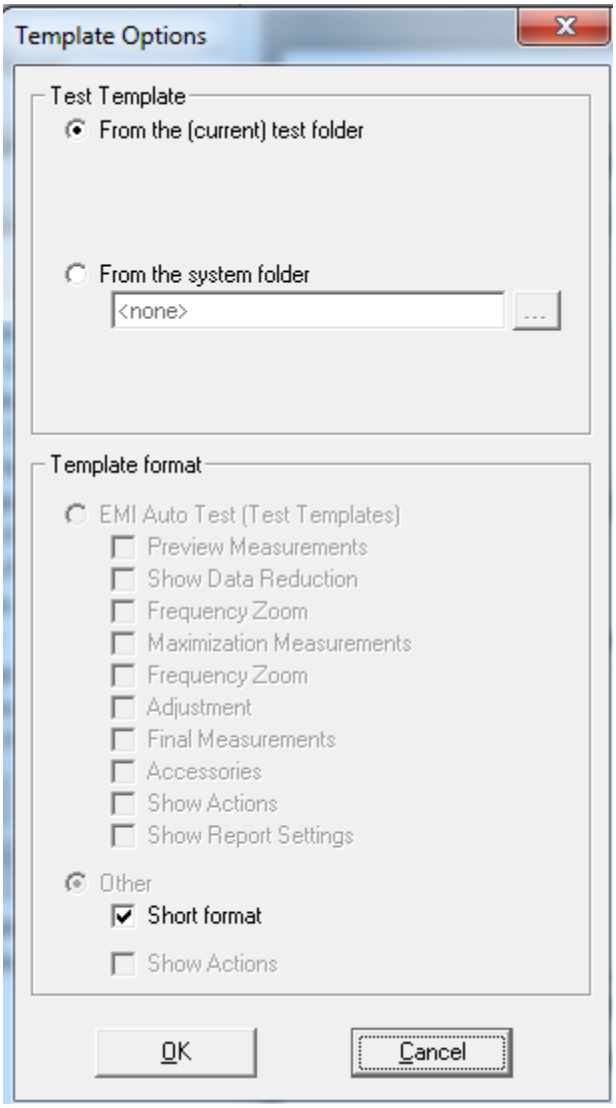


Fig. 7-9: Test template details

In the left window toolbar under **Selected Components** (Fig. 7-6), double-click on "Table" Table to select the type of tables required in the report.

Under **Table Name**, click on ... to select table types.

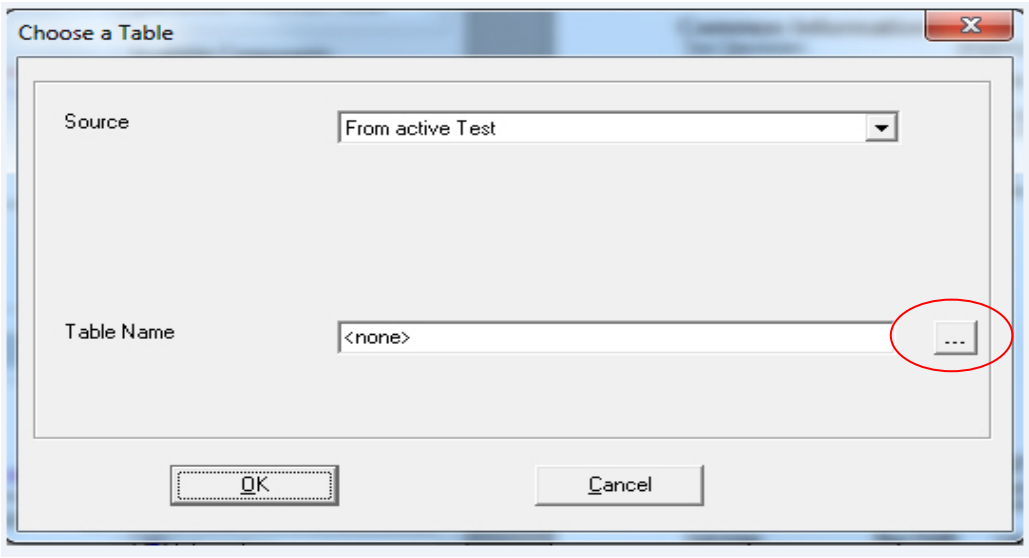


Fig. 7-10: Table selection

In the left window toolbar under **Selected Components** (Fig. 7-6), double-click on "Graphics" Graphics to select the type of graphs required in the report.

More than one graph can be added to the report if the option is available.

From **Graphics Display**, under the field **Graphics Arrangement**, we recommend selecting "2 rows x 1 column" for optimum display.

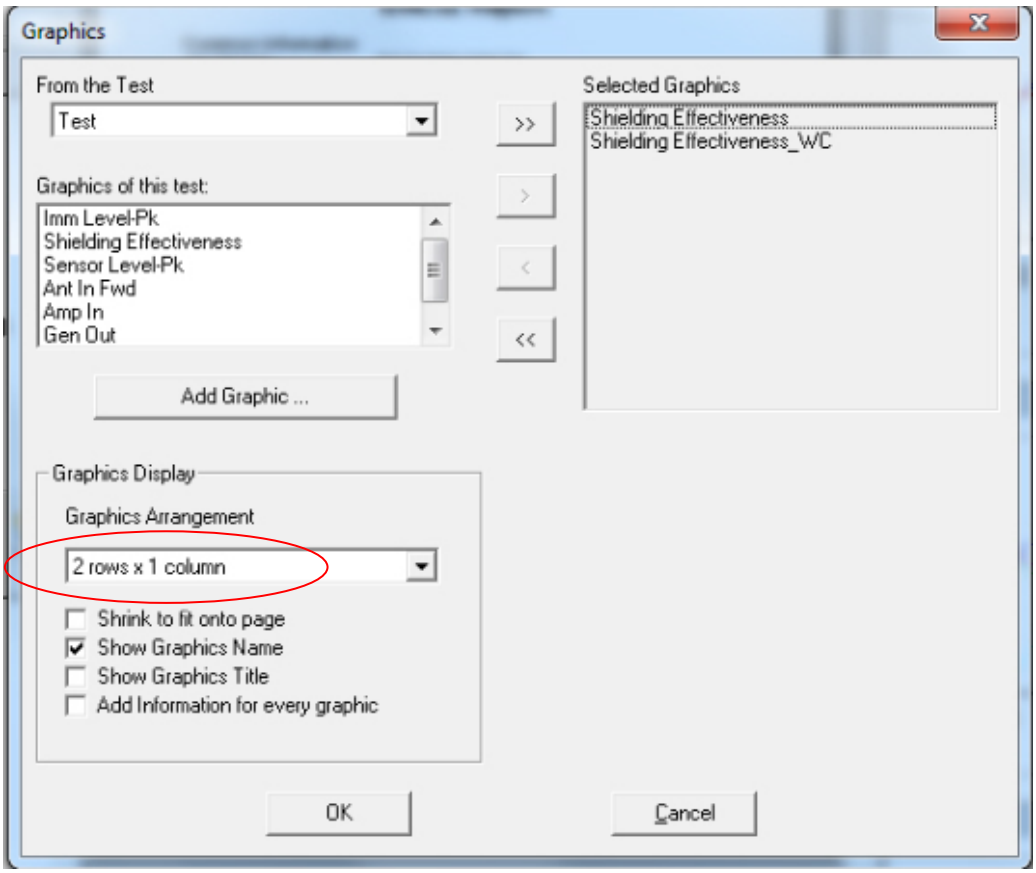
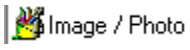


Fig. 7-11: Graphics details

In the left window toolbar under **Selected Components** (Fig. 7-6), double-click on "Image/Photo" 

to select any required image or photo for SE into the report.

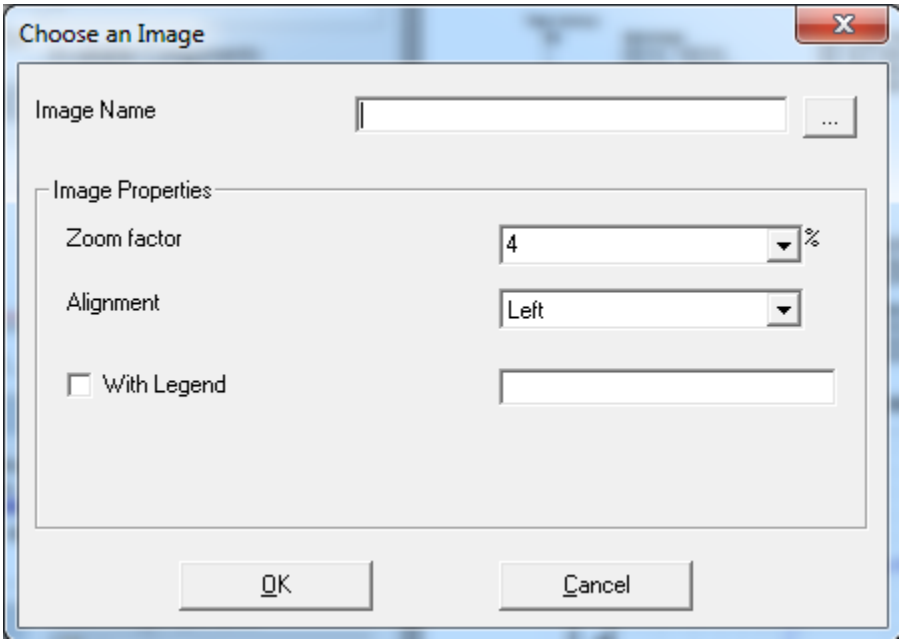


Fig. 7-12: Image/photo selection

In the left window toolbar under **Available Components** (Fig. 7-6), click on "Export the report"  to export and save the final test report. Three types of file formats are available: PDF, RTF and HTML.

Select ‘Save to the selected directory” and save the report to your desired file location.

Click OK to save the report.

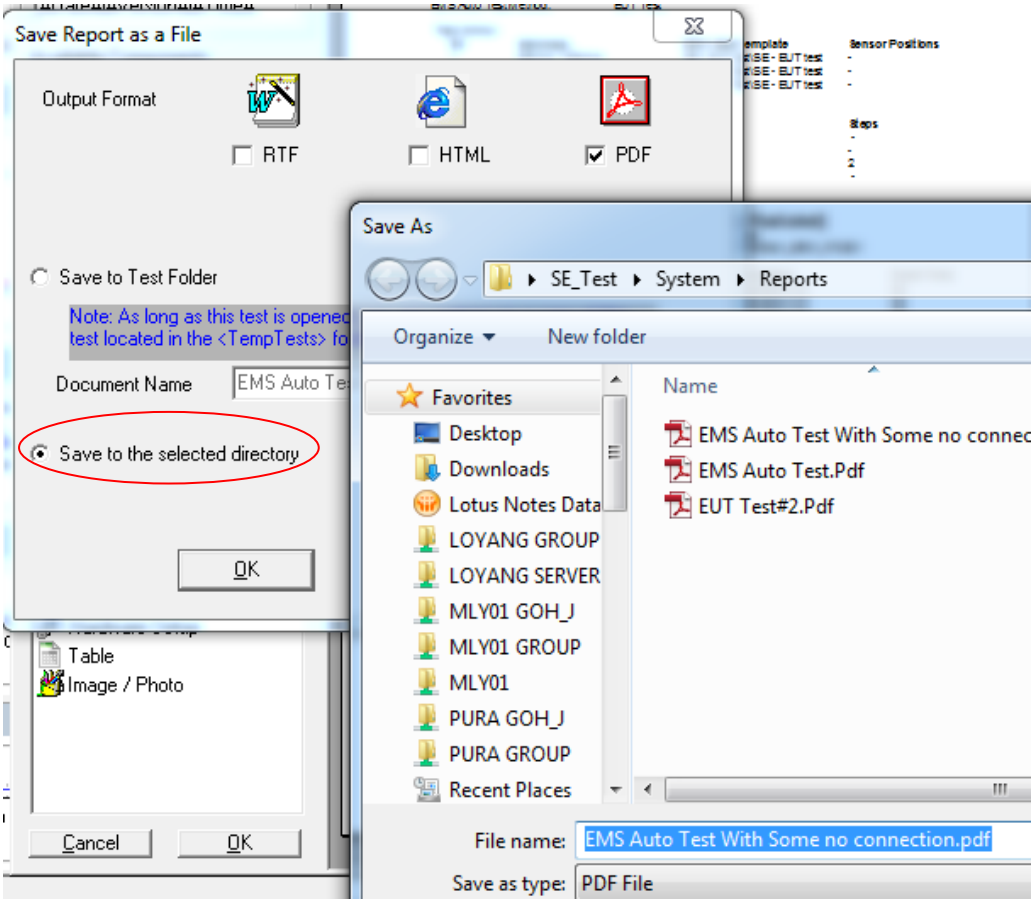


Fig. 7-13: Saving of report

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Regional contact

Europe, Africa, Middle East
+49 89 4129 12345
customersupport@rohde-schwarz.com

North America
1 888 TEST RSA (1 888 837 87 72)
customer.support@rsa.rohde-schwarz.com

Latin America
+1 410 910 79 88
customersupport.la@rohde-schwarz.com

Asia Pacific
+65 65 13 04 88
customersupport.asia@rohde-schwarz.com

China
+86 800 810 82 28 |+86 400 650 58 96
customersupport.china@rohde-schwarz.com

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Rohde & Schwarz GmbH & Co. KG
Mühldorfstraße 15 | 81671 Munich, Germany
Phone + 49 89 4129 - 0 | Fax + 49 89 4129 – 13777

www.rohde-schwarz.com