Application Note

TS-EMF

System for RF Exposure Measurements

System Check with Tri-Axis Sensor (Isotropic Antenna)

1 Introduction

The three axes of the Tri-Axis sensor (isotropic antenna) of the TS-EMF are switched to a single output via FET-switches. If no supply voltage or no control voltage is applied, the FET-switches are in an undefined semi-conductive state. The three signals from the individual axes are summed up with undefined attenuation and phase interference effects and as another effect the signal of the switched axis decreases very slowly, after the supply / control voltage is removed. Thus, even in those undefined states, received signals can be seen on the display of a connected spectrum analyzer, and it may be difficult to determine, whether the sensor axes are correctly switched.

This application note describes simple and more detailed system checks for the TS-EMF to allow the customer to check his system for correct performance.

2 Supported Equipment

The RFEX currently supports the Rohde & Schwarz spectrum analyzers ESPI, FSP, FSU, FSL and the handheld spectrum analyzers of the FSH-family (FSH3, FSH6, FSH-TV). The measurements described have been done with the FSH. However, the principle is the same with other spectrum analyzers For decoding measurements also the TSMU is supported. However, this application note does not cover a system check using the TSMU.

The TS-EMF allows usage of different antennas and switching devices. This application note only describes the system check with the isotropic Tri-Axis Sensor available with the system.

3 Switching of the Sensor

The application note covers two ways of switching the sensor:

- through the Converter Box (TSEMF-CV)
- through the spectrum analyzer

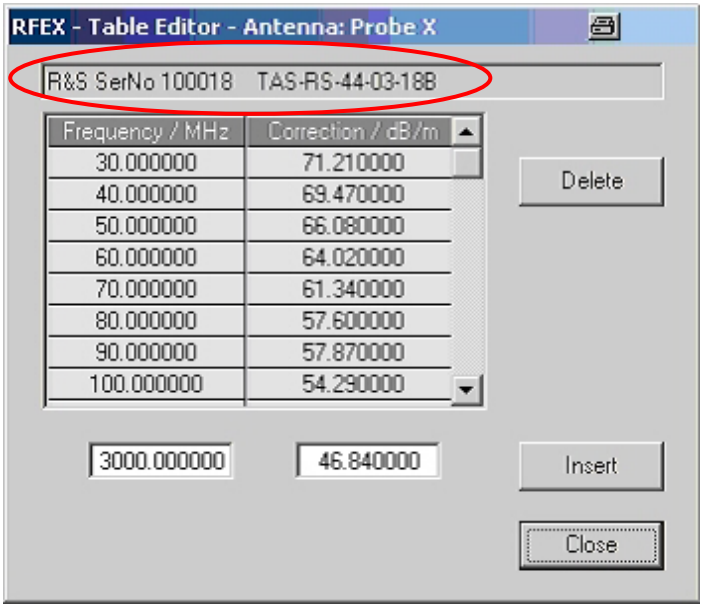
The interface for switching the sensor is set in the RFEX hardware menu (→ Configuration → Hardware → Switch Unit). Whether the sensor is switched through the analyzer or through the Converter Box does not affect the result.

4 Sensor Recognition

During manual sensor switching via the RFEX and also during test, the sensor is checked by the software. Due to changes in the hardware, the recognition of the sensor depends on the built standard. Thus, the RFEX checks the serial number of the antenna, which is recorded in

the antenna calibration files. In order to avoid unnecessary trouble-shooting activities, the antenna calibration files delivered with the sensor must be copied from the hardlock (system 1158.9295.03) or from the CD, in case the standalone system (FSH plus isotropic antenna) 1158.9295.13 is used with the RFEX (TSEMF-K1).

	**The RFEX checks the serial number of the individual Tri-Axis Sensor. That information is included in the antenna calibration files.** **In order to avoid errors or wrong measurements, the antenna calibration files have to be copied to the system !**



The menu File → Antennas → Copy from Hardlock copies the data to the PC working directory. If the files are copied manually from any other media, they have to be copied to the directory \\RFEX\Data\Antennas

5 System Check Options

	**For all checks with radiated signals, the operator has to be aware, that the environmental conditions have considerable effect on the results and that also his presence changes the field characteristics.** **For a minimum traceability, no bigger metal parts should be near the sensor during the check and the operator should be as far away from the sensors as possible.**

	**To observe the individual axes, be sure, that the spectrum analyzer is** **not set to Trace Mode Max Hold**

5.1 Simple System Check

The check can be done with any known environmental signal. As the operator influence rapidly increases with low frequencies, signals above 200 MHz should be used.

The check can be done as follows:

The sensor can be placed in any position (but not near a metal surface). The spectrum analyzer is manually set so that the signal can nicely be seen on the spectrum analyzer. The sensor is switched to X, Y and Z through the RFEX. If the sensor is properly working, in most cases a difference between 5 and 10 dB can be seen between the individual axes. If the difference is smaller, a change of position might help. If the signal change continues to be very small, there is potential risk of a failure or a missing supply and further checks are required.

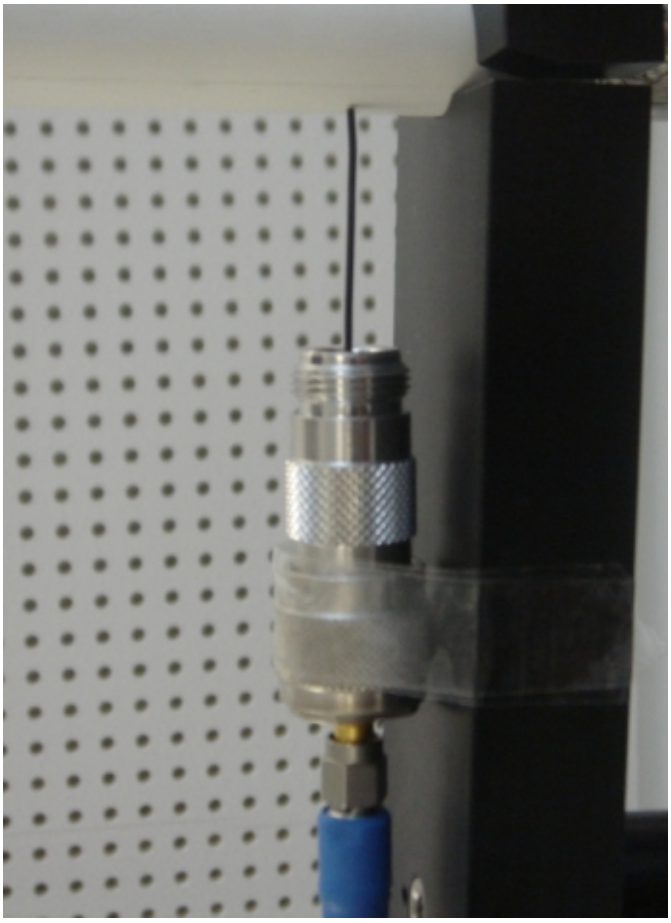
A rough calculation should be made, whether the results are reasonable. If the antenna factor (e.g. roughly 35 dB/m @ 900 MHz) is added to the marker peak value on the spectrum analyzer in dBµV, the result in dBµV/m is roughly the measured field strength.

5.2 System Check with Signal Generator

The picture below shows, how a provisional transmit antenna could look like. A piece of wire has been pushed put into the inner conductor of an N-female adapter. The wire has been cut so that it juts out of the connector for about 3 cm.

In the example setup, on the second picture, the provisional antenna has been fixed with tape on the antenna holder delivered with the system. The distance to the sensor head (lowest part of the blue radome on the picture is approximately 17 cm.

The position of the X - and Y-axis is marked with a little spot at the equator of the radome (X is number 1 and Y is number two in the antenna calibration document).



The FSH-screenshots on the next page have been taken with the measurement setup above. The only difference is, that the transducer factors have been applied as described in the next chapter, so that the reading is in dBµV/m.

The following setting were used on the signal generator / spectrum analyzer:

Signal Generator:
900 MHz, 10 dBm , RF-cable of 3 m length.

Spectrum Analyzer
Freq 900 MHZ / Span 1 MHz
RBw 100 kHz / Sweep Time 100 ms / Ref Level 96 dBµV / PreAmp Off
RMS-detector
Trace Mode Clear Write !! **Accessories: NONE !**

With this setup the following signal strength indicated on the FSH have been achieved:

X-Axis 78.0 dBµV
Y-axis 68.7 dBµV
Z-Axis 63.8 dBµV

Again the warning, that the value are just indicative and individual readings can change easily by 10 dB through a different environment. However, as long, as the operator does not move and nothing is changed, the indicated signal strength may be as constant as +- 0.2 dB.

A good indication for a correct function of the sensor setting is also, if the Y value becomes higher than the X value, when the Y-Axis is turned toward the antenna. However, due to lack of field uniformity it cannot be expected, that X – an Y- values exactly swap in this case.

5.3 System Check with Transducer Table

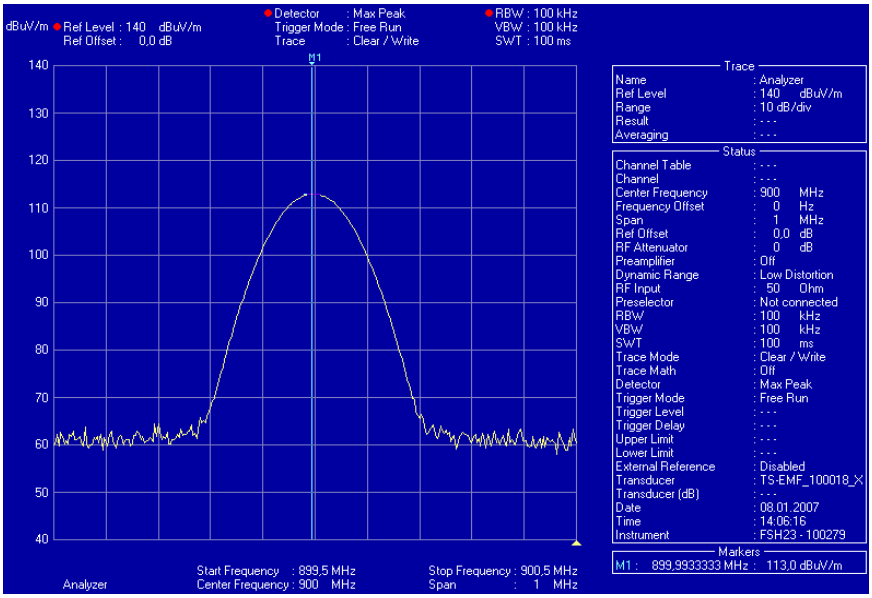
To get a direct indication of the field strength measured, it is also possible to load the transducer tables of the sensor into the FSH using the FSH-view software. Afterwards the transducers have to be activated on the FSH. Normally, this mode is only used for stand-alone measurements with isotropic antenna and FSH (in case of the standalone system the transducer tables for the FSH are available on CD). An EXCEL-tool to convert the antenna factors to transducer tables is available on the TS-EMF Internet pages. For checks with manual switching, the transducer tables can also be used and the sensor controlled with the RFEX. In this case, the corrected readings are directly in dBµV/m.

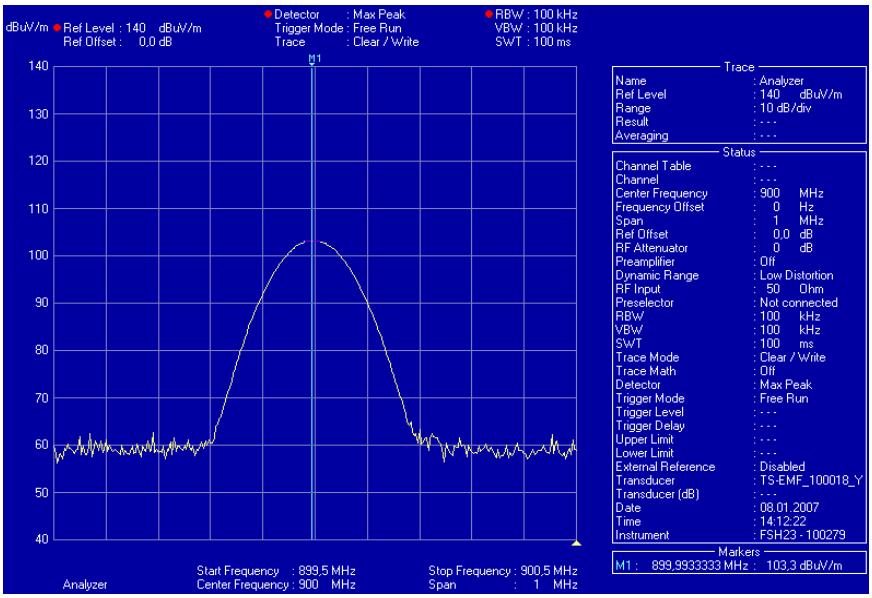
The screenshots on the next page have been taken after activation of the transducer factors of the FSH.

5.4 Service & Upgrade of Isotropic Antenna

The Tri-Axis Sensor does not contain user serviceable parts. If the sensor does not measure correctly or does not switch, it has to be sent to the Rohde & Schwarz Service department for check and repair, if applicable. The service department will provide an estimate of the repair costs.

If he sensor has to sent for service, the customer should consider, whether a calibration should be carried out at the same time. Furthermore, for older sensors Rohde & Schwarz recommends a modification to the latest built standard. Please ask the Rohde & Schwarz Service Department for details and for a quotation under Sercice@Rohde-Schwarz.com.


dBuV/m
Ref Level : 140 dBuV/m
Ref Offset : 0,0 dB
Detector : Max Peak
Trigger Mode : Free Run
Trace : Clear / Write
RBW : 100 kHz
VBW : 100 kHz
SWT : 100 ms
M1
140
130
120
110
100
90
80
70
60
50
40
Start Frequency : 899,5 MHz
Center Frequency : 900 MHz
Stop Frequency : 900,5 MHz
Span : 1 MHz
Analyzer
Trace
Name : Analyzer
Ref Level : 140 dBuV/m
Range : 10 dB/div
Result : - - -
Averaging : - - -
Status
Channel Table : - - -
Channel : - - -
Center Frequency : 900 MHz
Frequency Offset : 0 Hz
Span : 1 MHz
Ref Offset : 0,0 dB
RF Attenuator : 0 dB
Preamplifier : Off
Dynamic Range : Low Distortion
RF Input : 50 Ohm
Preselector : Not connected
RBW : 100 kHz
VBW : 100 kHz
SWT : 100 ms
Trace Mode : Clear / Write
Trace Math : Off
Detector : Max Peak
Trigger Mode : Free Run
Trigger Level : - - -
Trigger Delay : - - -
Upper Limit : - - -
Lower Limit : - - -
External Reference : Disabled
Transducer : TS-EMF_100018_X
Transducer (dB) : - - -
Date : 08.01.2007
Time : 14:06:16
Instrument : FSH23 - 100279
Markers
M1 : 899,9933333 MHz : 113,0 dBuV/m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Center Frequency : 900 MHz
Frequency Offset : 0 Hz
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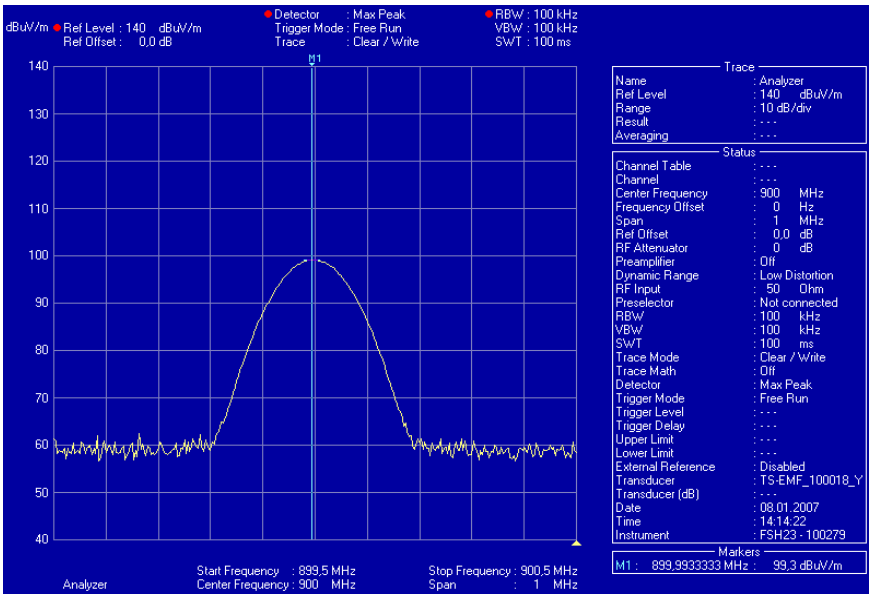
Ref Offset : 0,0 dB
RF Attenuator : 0 dB
Preamplifier : Off
Dynamic Range : Low Distortion
RF Input : 50 Ohm
Preselector : Not connected
RBW : 100 kHz
VBW : 100 kHz
SWT : 100 ms
Trace Mode : Clear / Write
Trace Math : Off
Detector : Max Peak
Trigger Mode : Free Run
Trigger Level : - - -
Trigger Delay : - - -
Upper Limit : - - -
Lower Limit : - - -
External Reference : Disabled
Transducer : TS-EMF_100018_Y
Transducer (dB) : - - -
Date : 08.01.2007
Time : 14:12:22
Instrument : FSH23 - 100279
Markers
M1 : 899,9933333 MHz : 103,3 dBuV/m


dBuV/m
Ref Level : 140 dBuV/m
Ref Offset : 0,0 dB
Detector : Max Peak
Trigger Mode : Free Run
Trace : Clear / Write
RBW : 100 kHz
VBW : 100 kHz
SWT : 100 ms
M1
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Start Frequency : 899,5 MHz
Center Frequency : 900 MHz
Stop Frequency : 900,5 MHz
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Analyzer
Trace
Name : Analyzer
Ref Level : 140 dBuV/m
Range : 10 dB/div
Result : - - -
Averaging : - - -
Status
Channel Table : - - -
Channel : - - -
Center Frequency : 900 MHz
Frequency Offset : 0 Hz
Span : 1 MHz
Ref Offset : 0,0 dB
RF Attenuator : 0 dB
Preamplifier : Off
Dynamic Range : Low Distortion
RF Input : 50 Ohm
Preselector : Not connected
RBW : 100 kHz
VBW : 100 kHz
SWT : 100 ms
Trace Mode : Clear / Write
Trace Math : Off
Detector : Max Peak
Trigger Mode : Free Run
Trigger Level : - - -
Trigger Delay : - - -
Upper Limit : - - -
Lower Limit : - - -
External Reference : Disabled
Transducer : TS-EMF_100018_Y
Transducer (dB) : - - -
Date : 08.01.2007
Time : 14:14:22
Instrument : FSH23 - 100279
Markers
M1 : 899,9933333 MHz : 99,3 dBuV/m