Königswinkel 10
32825 Blomberg
Germany
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TEST REPORT

Measurement according to
FCC Part 15.109

Test Report Reference: R30759aFCC Edition 2

Equipment under Test:

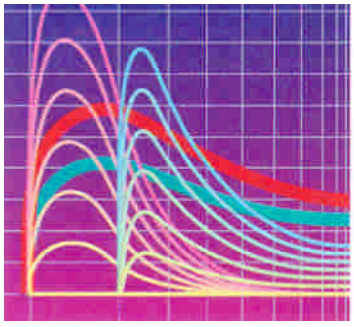
TSS / SG-G3/1,
Ser.-No.: 400016107

TSS / DA 3,
Ser.-No.: 10003357, 10003364, 10003363, 10003367

Applicant: BERU AG

Manufacturer: BERU AG

Test Laboratory
(CAB)
accredited by
DATech e.V.
in compliance with DIN EN ISO/IEC 17025
under the
Reg. No. TTI-P-G071/94-11
and listed by
FCC 31040/SIT1300F2



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1 IDENTIFICATION

1.1 APPLICANT

Name:	BERU AG
Address:	Mörikestraße 155
	71636 Ludwigsburg
Country:	Germany
Name for contact purposes	Zlatan Saric
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Fax:	+ 49-7141-132-589
e-mail address:	Zlatan.saric@beru.de

1.2 MANUFACTURER

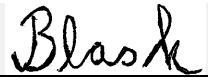
Name:	BERU AG
Address:	Mörikestraße 155
	71636 Ludwigsburg
Country:	Germany
Name for contact purposes	Zlatan Saric
Tel:	+ 49-7141-132-789
Fax:	+ 49-7141-132-589
e-mail address:	Zlatan.saric@beru.de

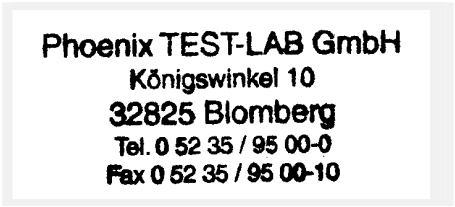
1.3 DATES

Date of Receipt of Test Sample:	28 October 2003
Start of test:	28 October 2003
Finish of test:	30 October 2003

1.4 TEST LABORATORY

The tests were carried out at: **PHOENIX TEST-LAB GmbH**
Königswinkel 10
D-32825 Blomberg **Phone:** **+49 (0) 52 35 / 95 00-0**
Germany **Fax:** **+49 (0) 52 35 / 95 00-10**

Test engineer:	Raimund Blask		19 November 2003
	name	signature	date
Test report checked:	Bernd Steiner		19 November 2003
	name	signature	date



stamp

1.5 RESERVATION

This test report is only valid in its original form.

The test results herein refer only to the tested sample. PHOENIX TEST-LAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TEST-LAB Logo and the TEST REPORT REFERENCE.

1.6 NORMATIVE REFERENCES

[1] **ANSI C63.4-1992** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

[2] **FCC 47 CFR Part 15 (13 March 2003)** Radio Frequency Devices

1.7 TEST RESULTS

The requirements of this test document are fulfilled by the equipment under test. The complete test results are presented in the following.

2 TECHNICAL DATA OF EQUIPMENT

2.1 DEVICE UNDER TEST

Type of equipment:	Short range device
Type designation:	Control unit: TSS / SG-G 3.1 Ser.-No. 400016107
	RF-part: TSS / DA 3 Ser.-No. 10003357, 10003364, 10003363, 10003367
Highest operating frequency	315 MHz

* declared by the applicant

Ports/Connectors

Identification	Connector		Length
	EUT (control unit)	Ancillary	
Antenna 1-4	J3 (40 pole customised connector)	fixed	1.5 m
Power supply	J3 (40 pole customised connector)	fixed	1.5 m
CAN-bus	J3 (40 pole customised connector)	9 pole Sub-D connector	1.5 m

2.2 PEREPHERY DEVICES

The ancillary equipment mentioned below was in use:

The tests were carried out with an unmodified test sample. The test sample was connected to a personal computer outside the anechoic chamber via CAN-bus and fibre optic converter to monitor the function of the receiver.

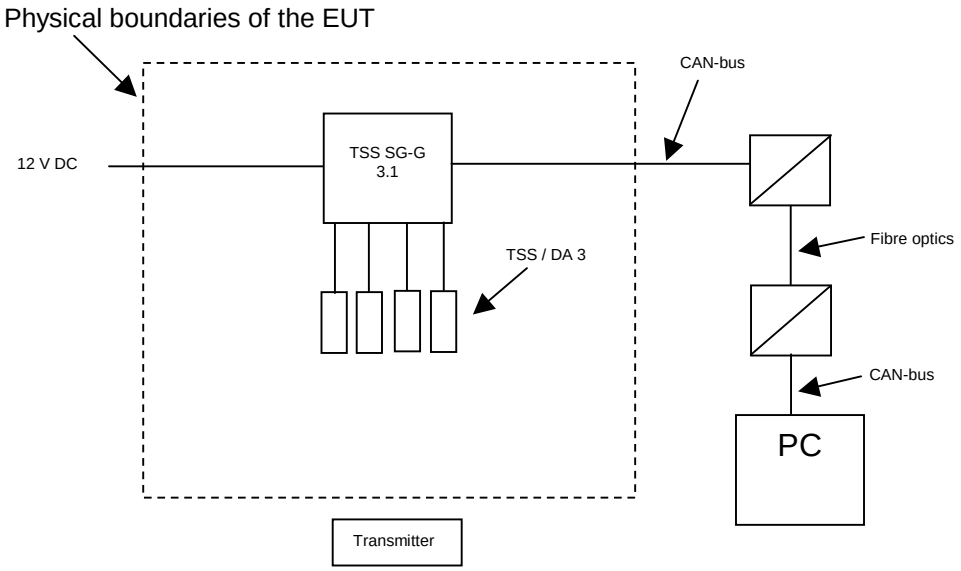
2.3 MODIFICATIONS

No modifications necessary to fulfil the limits.

3 OPERATIONAL STATES AND PHYSICAL BOUNDARIES

The EUT was tested in normal operation mode.
The transmitter was stimulated with different air pressure to transmit every 1 s.
The received data (received by the EUT) were send via CAN-bus to the PC.

The physical boundaries of the Equipment Under Test are shown below.



4 MEASUREMENT OVERVIEW

4.1 EMISSION

Radiated emissions						
No.	Application	Frequency range	Limits (quasi peak)	Reference standard	Remark	Status
1	Enclosure port	30 to 88 MHz 88 to 216 MHz 216 to 960 MHz above 960 MHz	40.0 dBµV/m at 3 m 43.5 dBµV/m at 3 m 46.0 dBµV/m at 3 m 54.0 dBµV/m at 3 m	ANSI C 63.4 (1992); FCC Part 15.109 (03/13/2003)	-	Passed (Class B)
Conducted emissions on DC						
No.	Application	Frequency range	Limits	Reference standard	Remark	Status
2	DC input port	0.15 to 0.5 MHz 0.5 to 5 MHz 5 to 30 MHz	66 to 56 * dBµV Q 56 to 46 * dBµV AV 56 dBµV Q 46 dBµV AV 60 dBµV Q 50 dBµV AV	ANSI C 63.4 (1992); FCC Part 15.107 (03/13/2003)	-	Passed (Class B)
* Decreases with the logarithm of the frequency						

4.2 RADIATED EMISSIONS (30 MHz to 4 GHz)

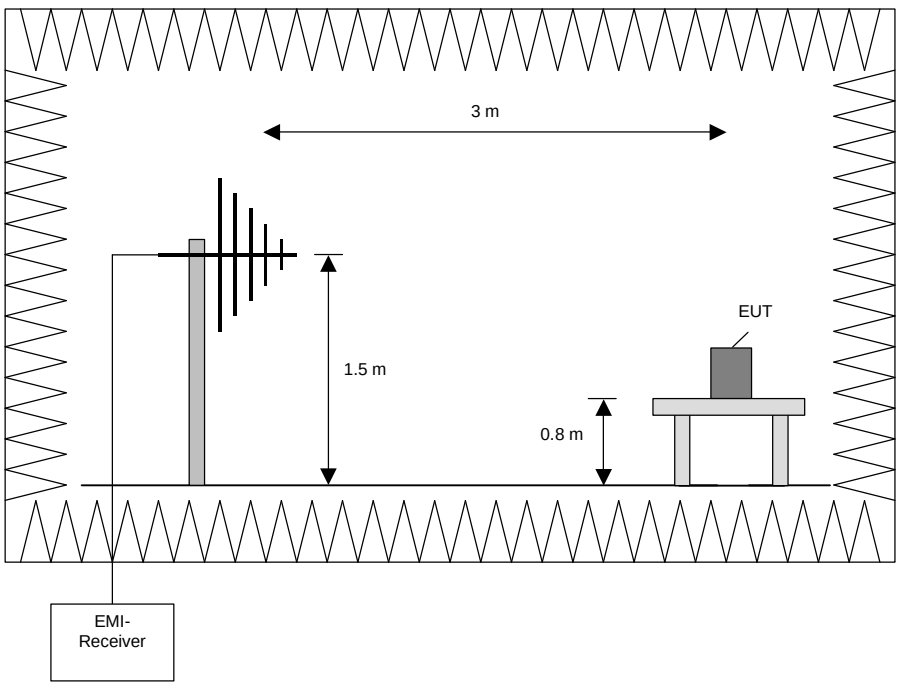
The radiated emission measurement is subdivided in two stages.

Preliminary measurement:
In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-1992 [1].

The frequency range 30 MHz to 1 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 120 kHz. The frequency range 1 GHz to 4 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0° to 360° and three orthogonal axis.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz
1 GHz to 4 GHz	1 MHz



Procedure of preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 200 MHz, 200 MHz to 1 GHz and 1 GHz to 4 GHz. The following procedure will be used:

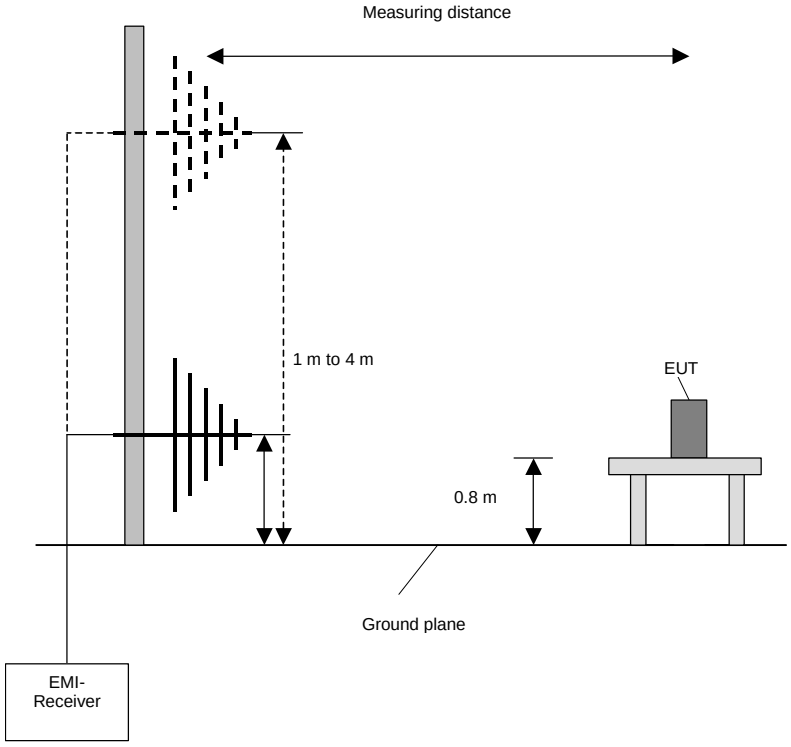
1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0°
2) Manipulate the system cables within the range to produce the maximum level of emission
3) Rotate the EUT by 360° to maximize the detected signals.
4) Make a hardcopy of the spectrum
5) Measure the frequency of 3 highest detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6) Repeat steps 1) to 4) with the other orthogonal axes
7) Repeat steps 1) to 5) with the vertical polarisation of the measuring antenna.

Final Measurement (30 MHz to 1 GHz):

In the second stage a final measurement will be performed on selected frequencies found in the preliminary measurement. The final measurement in the frequency range 30 MHz to 1 GHz was done on an open area test site during this test the EUT will be rotated in three orthogonal axis in the range of 0° to 360°, the measuring antenna will be set to horizontal and vertical polarisation and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.
The final measurement in the frequency range 1 GHz to 4 GHz was done in the fully anechoic chamber. During this test the EUT will be rotated in three orthogonal axis in the range of 0° to 360°, the measuring antenna will be set to horizontal and vertical polarisation to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz
1 GHz to 4 GHz	1 MHz



Procedure of final measurement:

The following procedure will be used:

1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23°
2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
3) Rotate the EUT by 45° and repeat 2) until an azimuth of 337° is reached.
4) Repeat 1) to 3) for the other orthogonal antenna polarization.
5) Move the antenna and the turntable to the position where the maximum value is detected.
6) Measure while moving the antenna slowly +/- 1 m
7) Set the antenna to the position where the maximum value is found
8) Measure while moving the turntable +/- 45°
9) Set the turntable to the azimuth where the maximum value is found
10) Measure with Final detector (QP or AV) and note the value
11) Repeat 5) to 10) for each frequency
12) Repeat 1) to 11) for each orthogonal axes of the EUT

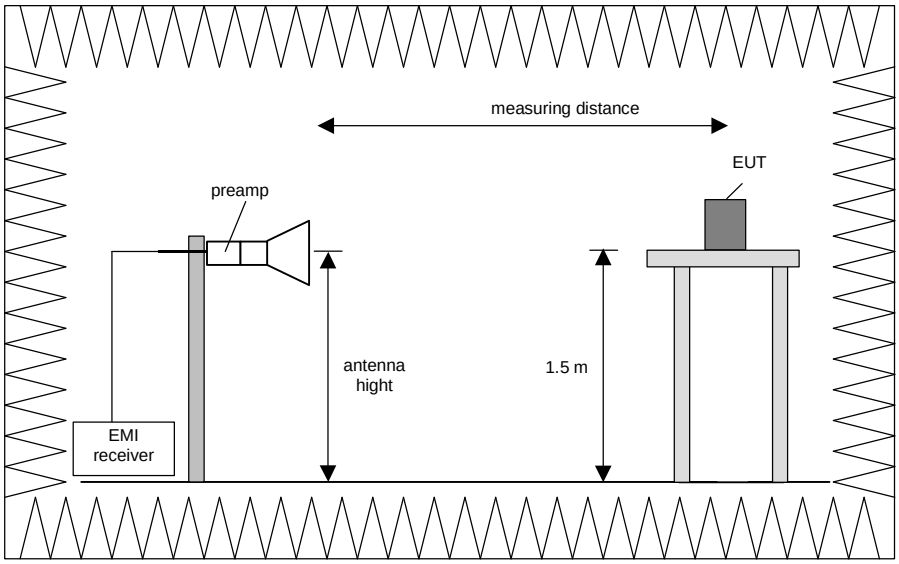
Final measurement (1 GHz to 4 GHz)

This measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-1992 [1].

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to MAX Hold mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. If the EUT is larger than the antenna beamwidth, the antenna will be moved to various positions, to cover the whole surface of the EUT. It might be possible to shorter the measuring distance to higher the measurement sensitivity.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 4 GHz.
The following procedure will be used:

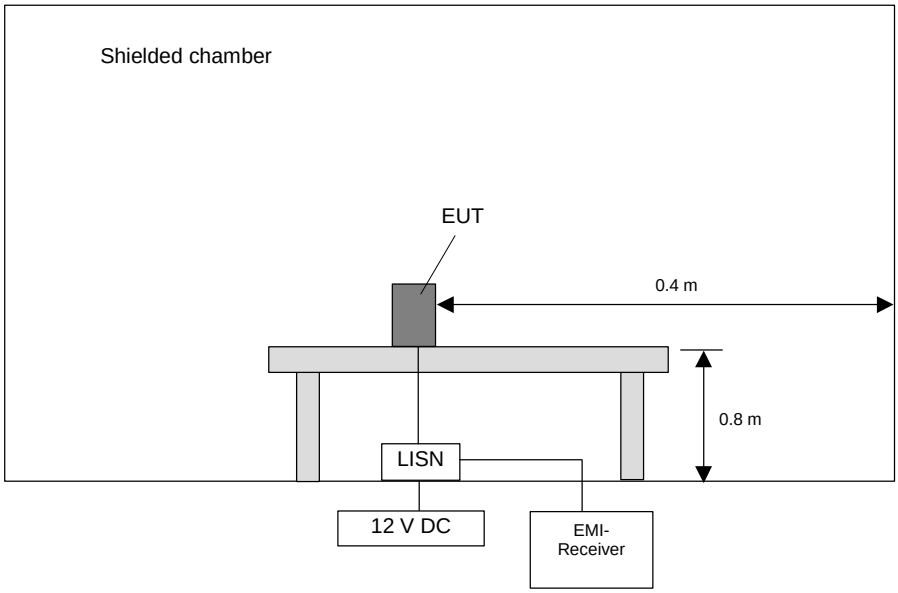
1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2) Rotate the EUT by 360 ° to maximize the detected signals.
3) Change the antenna polarisation.
4) Rotate the EUT by 360 ° to maximize the detected signals.
5) Make a hardcopy of the spectrum.
6) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarisation and azimuth and the peak and average detector, which causes the maximum emission.
8) Repeat steps 1) to 7) with the other orthogonal axes of the EUT if handheld equipment.
9) Repeat steps 1) to 8) for the next antenna spot if the EUT is larger than the antenna beamwidth.

4.3 CONDUCTED EMISSIONS ON DC MAINS (150 kHz to 30 MHz)

This test will be carried out in a shielded chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm above the ground plane. Floor-standing devices will be placed directly on the ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-1992 [1].

The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase of the AC mains network. If levels detected 10 dB below the appropriable limit, this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



5 RESULTS EMISSION MEASUREMENTS

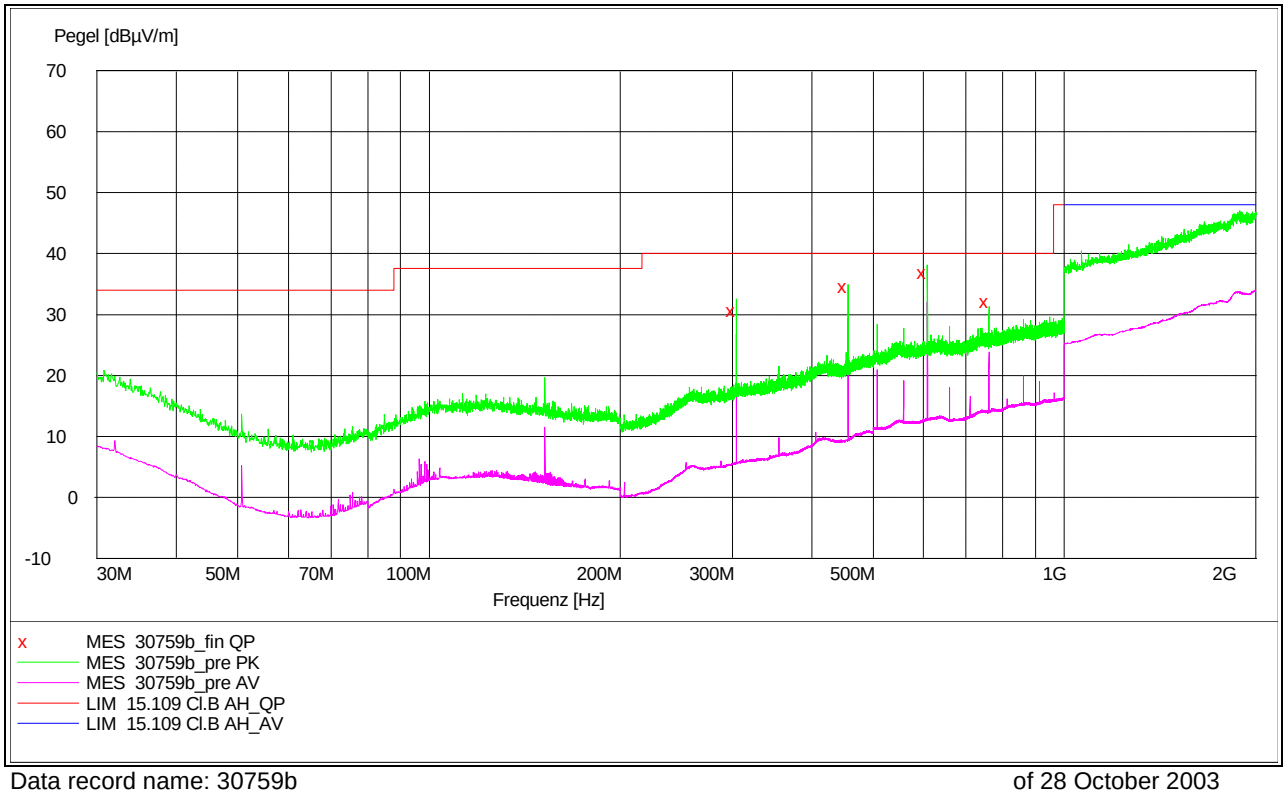
5.1 PRELIMINARY RADIATED EMISSION MEASUREMENT (30 MHz to 4 GHz)

Ambient temperature	20 °C	Relative humidity	55 %

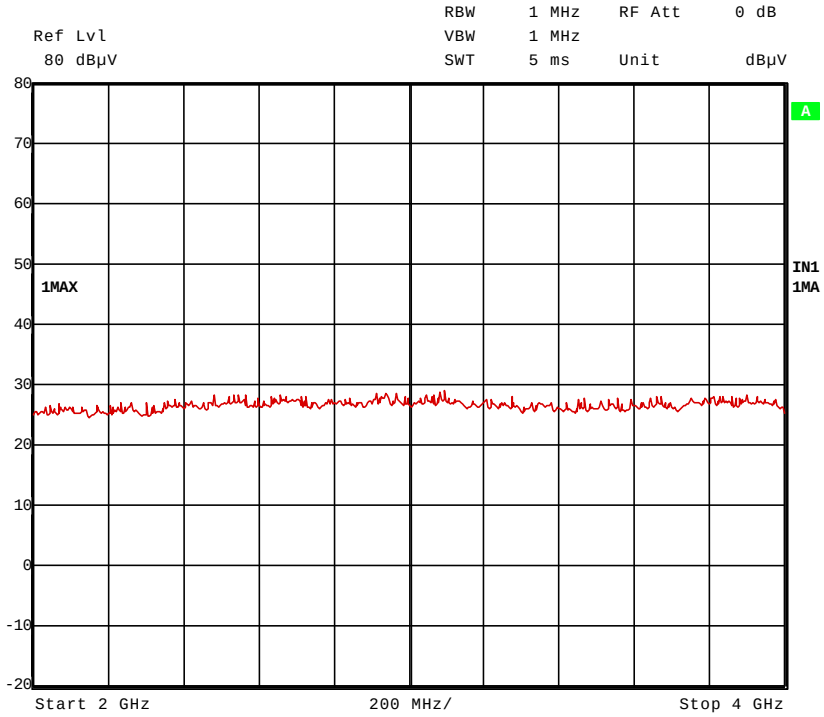
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: The cables of the EUT were necessary.

Test record: The test was carried out in normal operation mode of the EUT. All results are shown in the following.



Data record name: 30759b of 28 October 2003



30759FCC_3: 2 GHz to 4 GHz, normal operation mode

The following frequencies were found during the preliminary measurement:

152.160 MHz, 304.310 MHz, 456.460 MHz, 507.180 MHz, 557.900 MHz, 608.615 MHz, 659.325 MHz, 760.765 MHz

These frequencies were selected for the final measurement. The results of this measurement were documented on the following page.

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 35, 37, 38

5.2 FINAL RADIATED EMISSION MEASUREMENT (30 MHz to 1 GHz)

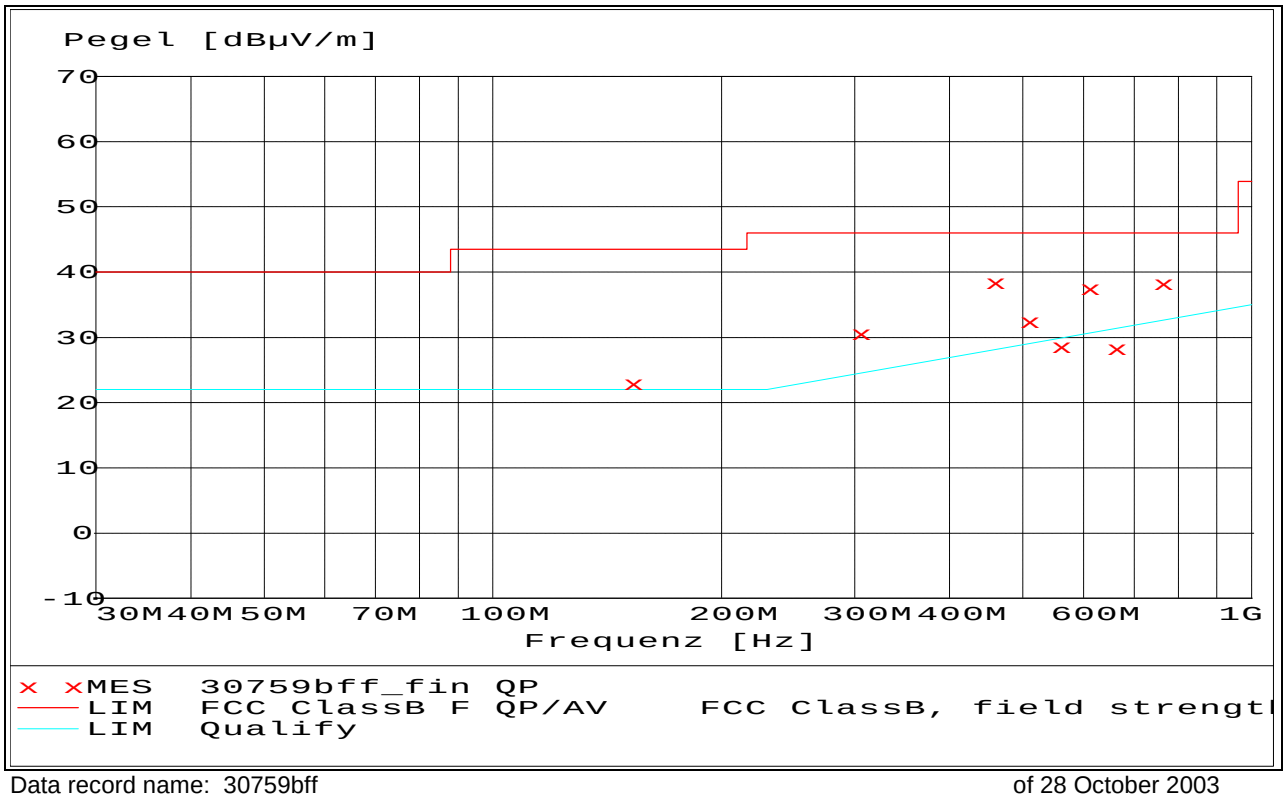
Ambient temperature	20 °C	Relative humidity	50 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: Cable run see annex C.

Test record: The test was carried out in normal operation mode of the EUT. All results are shown in the following.

The measured points marked with x are the results of the standard final measurement on the open area test site.



Data record name: 30759bff of 28 October 2003

The results of the standard subsequent measurement on the open area test site are indicated in the table below. The limits as well as the measured results (levels) refer to the above mentioned standard while taking account of the specified requirements for a 3m measuring distance.

Result measured with the quasi-peak detector:

(These values are marked in the above diagram by x)

Frequency MHz	Level dBµV/m	Transducer dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarisation
152.160000	22.80	13.0	43.5	20.7	284.0	287.00	HORIZONTAL
304.310000	30.50	14.8	46.0	15.5	100.0	146.00	HORIZONTAL
456.460000	38.40	19.1	46.0	7.6	181.0	36.00	HORIZONTAL
507.180000	32.40	20.1	46.0	13.6	152.0	152.00	HORIZONTAL
557.900000	28.50	22.6	46.0	17.5	149.0	224.00	HORIZONTAL
608.615000	37.50	22.2	46.0	8.5	138.0	337.00	HORIZONTAL
659.325000	28.30	22.5	46.0	17.7	125.0	171.00	HORIZONTAL
760.765000	38.30	24.8	46.0	7.7	100.0	171.00	HORIZONTAL

Data record name: 30759bff_fin QP of 28 October 2003

The transducer was calculated from the antenna factor and the cable loss.

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

14 – 20

5.3 FINAL RADIATED EMISSION MEASUREMENT (1 GHz to 4 GHz)

Ambient temperature	20 °C	Relative humidity	55 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: Cable run see annex C.

Test record: The test was carried out in normal operation mode of the EUT. All results are shown in the following.

Result measured with the peak detector:

Three highest spurious emissions									
Frequency GHz	Corrected Value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.

No significant radiated emission in the frequency range 1 to 4 GHz found.

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

20, 29, 31 – 37, 39

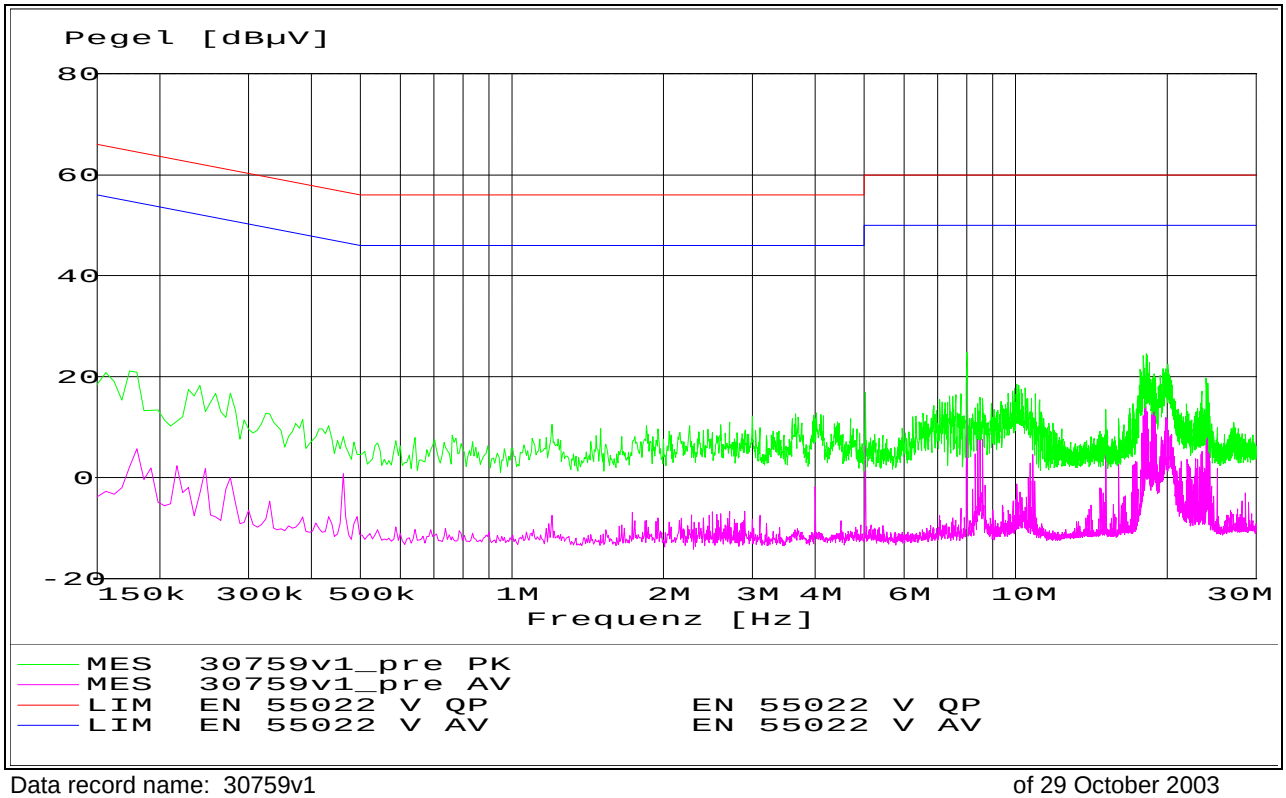
5.4 CONDUCTED EMISSION MEASURMENT ON DC MAINS (150 kHz to 30 MHz)

Ambient temperature	20 °C	Relative humidity	50 %

Position of EUT: The EUT was set-up on a wooden table of a height of 0.8 m.

Cable guide: The cables of the EUT were fixed on the wooden table. For further information of the cable guide refer to the pictures in annex C of this test report.

Test record: The test was carried out in normal operation mode of the EUT.
All results are shown in the following.



Data record name: 30759v1 of 29 October 2003

Test: Passed

TEST EQUIPMENT USED:

1, 2, 5, 6, 45 – 47

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

Emission measurement at AC mains and DC in / out ports at M4					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
1	Shielded chamber M4	-	Siemens	B83117S1-X158	480088
2	Measuring receiver	ESAI	Rohde & Schwarz	831953/001 833181/018	480025 480026
3	LISN	NSLK8128	Schwarzbeck	8128155	480058
4	DC-filter	B84266-A21-E13	Siemens	940164525	480099
5	AC-filter	B84299-D87-E3	Siemens	930262292	480097
6	EMI-Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M5					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
7	Fully anechoic chamber M5	-	Siemens	B83177-S1-X156	480073
8	Measuring receiver	ESVS30	Rohde & Schwarz	829673/012	480024
9	Controller	HD100	Deisel	100/324	480067
10	Antenna support	MA240	Deisel	228/314	480069
11	Turntable	DS412	Deisel	412/317	480070
12	Antenna	CBL6112C	Chase	2689	480327
13	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M6					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
14	Open area test site	-	Phoenix Test-Lab	-	480085
15	Measuring receiver	ESVS30	Rohde & Schwarz	829673/012	480024
16	Controller	HD100	Deisel	100/670	480139
17	Turntable	DS420HE	Deisel	420/620/80	480087
18	Antenna support	AS615P	Deisel	615/310	480086
19	Antenna	CBL6111 A	Chase	1643	480147
20	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M8

No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
21	Fully anechoic chamber M8	-	Siemens	B83117-E7019-T231	480190
22	Measuring receiver	ESMI	Rohde & Schwarz	843977/001 843530/018	480179 480180
23	Measuring receiver	ESCS 30	Rohde & Schwarz	828985/014	480270
24	Controller	HD100	Deisel	100/427	480181
25	Turntable	DS420	Deisel	420/435/97	480186
26	Antenna support	AS615P	Deisel	615/310	480187
27	Antenna	CBL6112 A	Chase	2034	480185
28	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M20					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303
30	Measuring receiver	ESMI	Rohde & Schwarz	843977/001 843530/018	480179 480180
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355
32	Controller	HD100	Deisel	100/670	480326
33	Turntable	DS420HE	Deisel	420/620/80	480315
34	Antenna support	AS615P	Deisel	615/310	480187
35	Antenna	CBL6112 B	Chase	2688	480328
36	Antenna	3115 A	EMCO	9609-4918	480183
37	RF-cable No. 30	RTK 081	Rosenberger	-	410141
38	EMI Software	ES-K1	Rohde & Schwarz	-	480111
39	RF-cable No. 5	RTK 081	Rosenberger		410097

Ancillary equipment used for testing					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
40	Outdoor test site	-	Phoenix Test-Lab	-	480293
41	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
42	Power supply	TOE 8852	Toellner	51712	480233

43	Decoupling clamp	FGZ 40x15E	Lüthi	4453	480224
44	Decoupling clamp	FGZ 40x15E	Lüthi	4452	480223
45	LISN	NSLK 8128-	Schwarzbeck	8128161	480138
46	LISN / Mains Network	MN2050B	Chase	1153	480146
47	AC power source / analyser	6813A	Hewlett Packard	3524A-00484	480155
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

All measurement equipment in use was calibrated (if necessary). The calibration intervals and the calibration history will be given out on request.

7 LIST OF ANNEXES

ANNEX A	**INTERNAL PHOTOGRAPHS OF THE TEST SAMPLE**:	**4 pages**
	EUT (TSS SG-G 3/1) PCB top view	30759eut7.jpg
	EUT (TSS SG-G 3/1) PCB rear view	30759eut8.jpg
	EUT (TSS / DA 3) PCB rear view	30759eut4.jpg
	EUT (TSS / DA 3) PCB top view	30759eut3.jpg
ANNEX B	**EXTERNAL PHOTOGRAPHS OF THE TEST SAMPLE**:	**2 pages**
	EUT (TSS SG-G 3/1) top view	30759eut9.jpg
	EUT (TSS / DA 3) top view	30759esd4.jpg
ANNEX C	**PHOTOGRAPHS OF THE TEST SET-UP**:	**2 pages**
	Test set-up radiated emission (fully anechoic chamber)	30759emi2.jpg
	Test set-up radiated emission (open area test-site)	30759emi13.jpg
	Test set-up conducted emission	30759kfz3.jpg