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32825 Blomberg
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TEST REPORT

Test Report Reference: R40458/2 Edition 1

Equipment under Test:

**Electronic Control Unit ECU, TSS/SG-G3/2,
Serial-No. 200002003**

**Digital antenna 315 MHz
TSS/DA3P, serial-No. 10001207**

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 71602 Ludwigsburg
Country:	Germany
Name for contact purposes:	Mr. Zlatan Saric
Phone:	+49-7141-132-798
Fax:	+49-7141-132-589
Mail address:	Zlatan.saric@beru.de
Applicant represented during the test by the following person:	-

1.2 MANUFACTURER

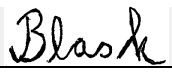
Name:	BERU AG
Address:	Mörikestraße 155 71602 Ludwigsburg
Country:	Germany
Name for contact purposes:	Mr. Zlatan Saric
Phone:	+49-7141-132-798
Fax:	+49-7141-132-589
Mail address:	Zlatan.saric@beru.de
Applicant represented during the test by the following person:	-

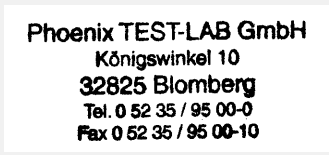
1.3 DATES

Date of receipt of test sample:	17 May 2004
Start of test:	17 May 2004
Finish of test:	18 May 2004

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		24 June 2004
	name	signature	date
Test report checked:	Bernd Steiner		24 June 2004
	name	signature	date



stamp

1.5 RESERVATION

This test report is only valid in its original form.

Any reproduction of its contents without written permission of the accredited test laboratory PHOENIX TEST-LAB GmbH is prohibited.

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 C63.4-2001** 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 (08 December 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:	ECU Electronic Control Unit TSS/SG-G3/2 Digital Antenna 315 MHz: TSS/DA3P
Type designation:	TSS/SG-G3/2, Serial-No. 200002003 TSS/DA3P, serial-No. 10001207
Highest internal frequency:	50.7167 MHz (internal rf-oscillator frequency)

The following external I/O cables were used:

Cable	Length	Shielding	Connector
Connection cable to 3 pin wiring plug	1.5 m	No	3 pin connector
-	-	-	-
-	-	-	-

2.2 PERIPHERY DEVICES

The following equipment was used as control unit and ancillary equipment:

The EUT was connected to an external Laptop and powered with a DC power supply.

2.3 MODIFICATIONS

No modifications necessary to fulfil the requirements.

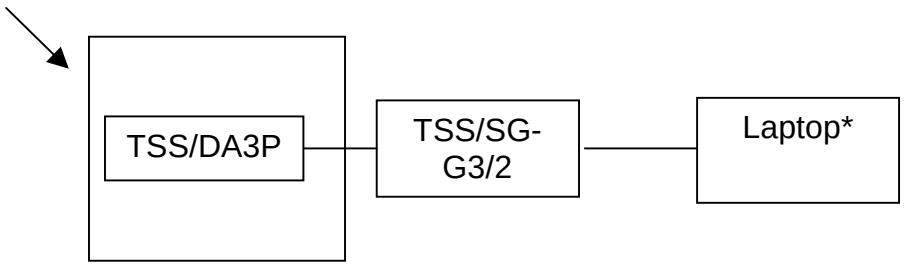
3 OPERATIONAL STATES AND PHYSICAL BOUNDARIES

For all measurements the EUT was tested in normal operation (receive) mode.

For the whole frequency range a preliminary measurement in a fully anechoic chamber with a measuring distance of 3 m was carried out to determine the frequencies, which were radiated by the EUT.
The final measurements for the frequency range 30 MHz to 1 GHz on the detected frequencies were carried out at on open area test site with ground plane.

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

Physical boundaries of the EUT:



* Laptop with Vector Tool “CANoe” to establish CAN communication to Control Unit (TSS/SG-G3/2).

4 LIST OF TEST MODULES

4.1 EMISSION

Radiated emissions FCC 47 CFR Part 15 section 15.109 [2]						
No.	Application	Frequency range	Limits (at 3 m distance)	Reference standard	Remark	Status
1	Unintentional radiator	30 to 88 MHz 88 to 216 MHz 216 to 960 MHz above 960 MHz	100 µV / m 150 µV / m 200 µV / m 500 µV / m	ANSI C63.4 (2001);	-	Passed
Conducted emissions FCC 47 CFR Part 15 section 15.107 [2]						
No.	Application	Frequency range	Limit QP	Limit AV	Remark	Status
2	Unintentional radiator	0.15 to 0.5 MHz 0.5 to 5 MHz 5 to 30 MHz	66 to 56 dBµV* 56 dBµV 60 dBµV	56 to 46 dBµV* 46 dBµV 50 dBµV	-	Passed
* Decreases with the logarithm of the frequency						

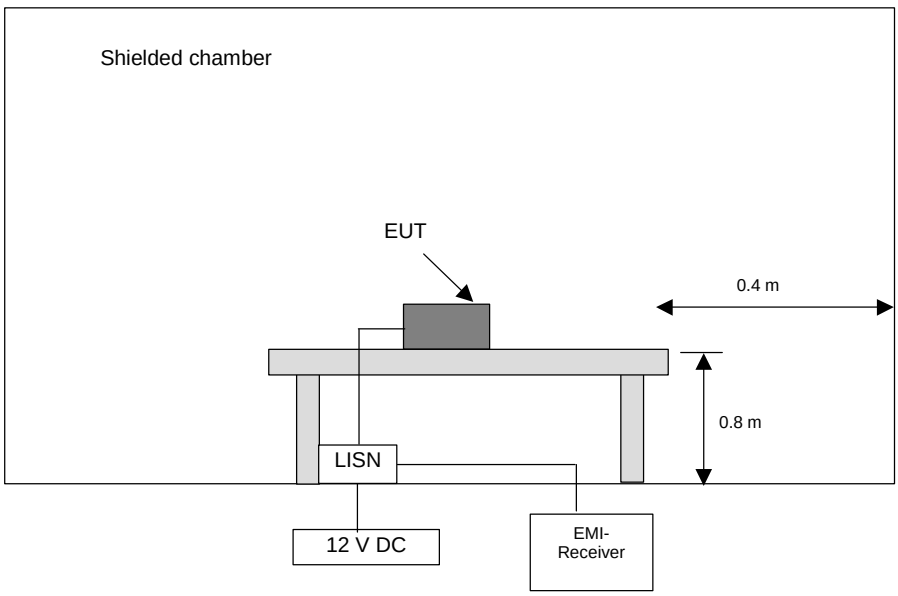
METHOD OF MEASUREMENT

4.2 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 DC 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



4.3 RADIATED EMISSIONS (30 MHZ TO 1 GHZ)

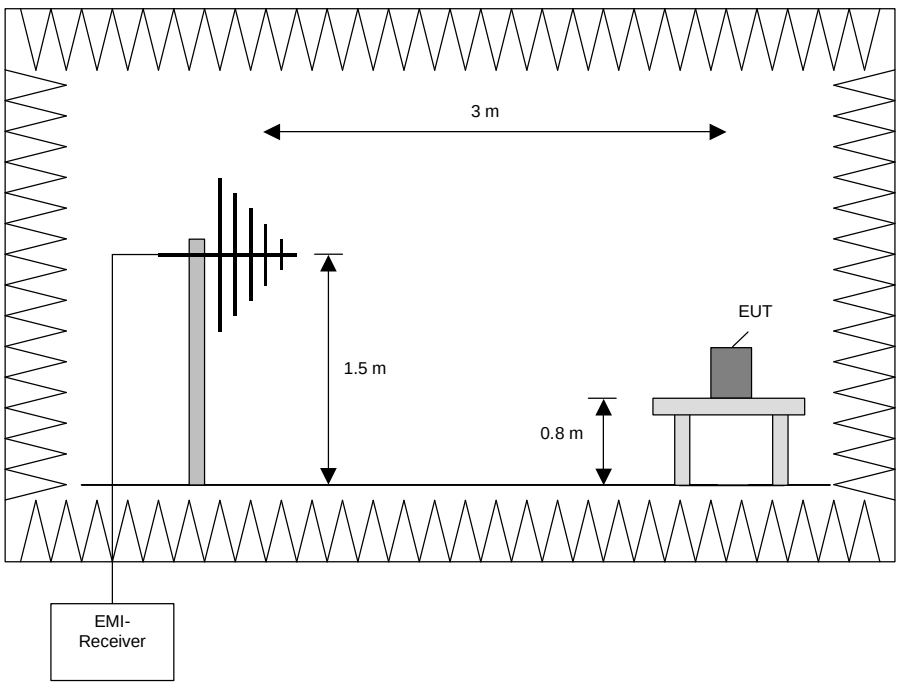
The radiated emission measurement is subdivided in two stages.

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 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



Procedure of preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.

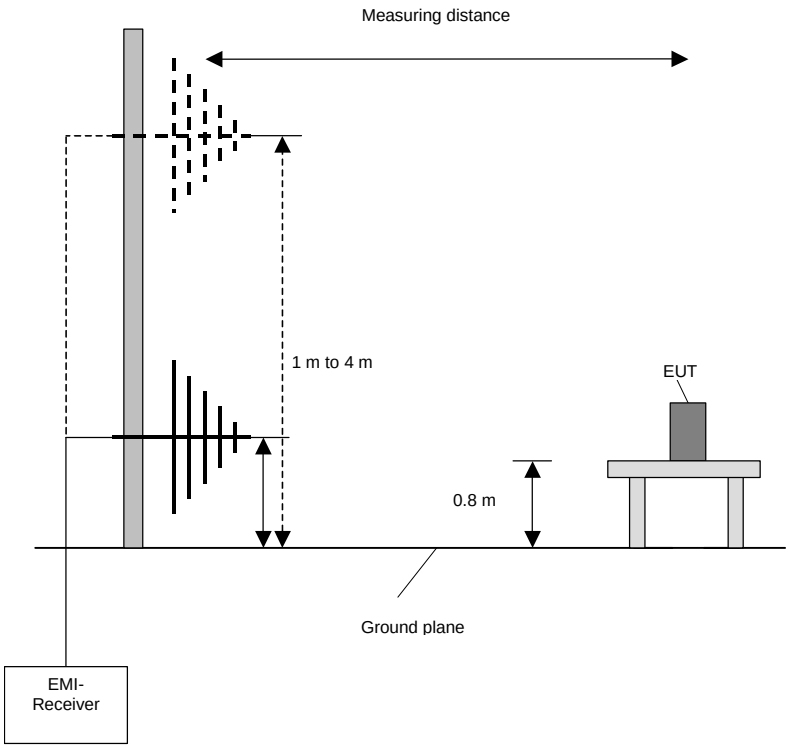
1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0°
2) Manipulate the system cables within the range to produce the maximum level of emission
3) Rotate the EUT by 360° to maximize the detected signals.
4) Make a hardcopy of the spectrum
5) Measure the frequency of 3 highest 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

5 TEST RESULTS EMISSION TEST

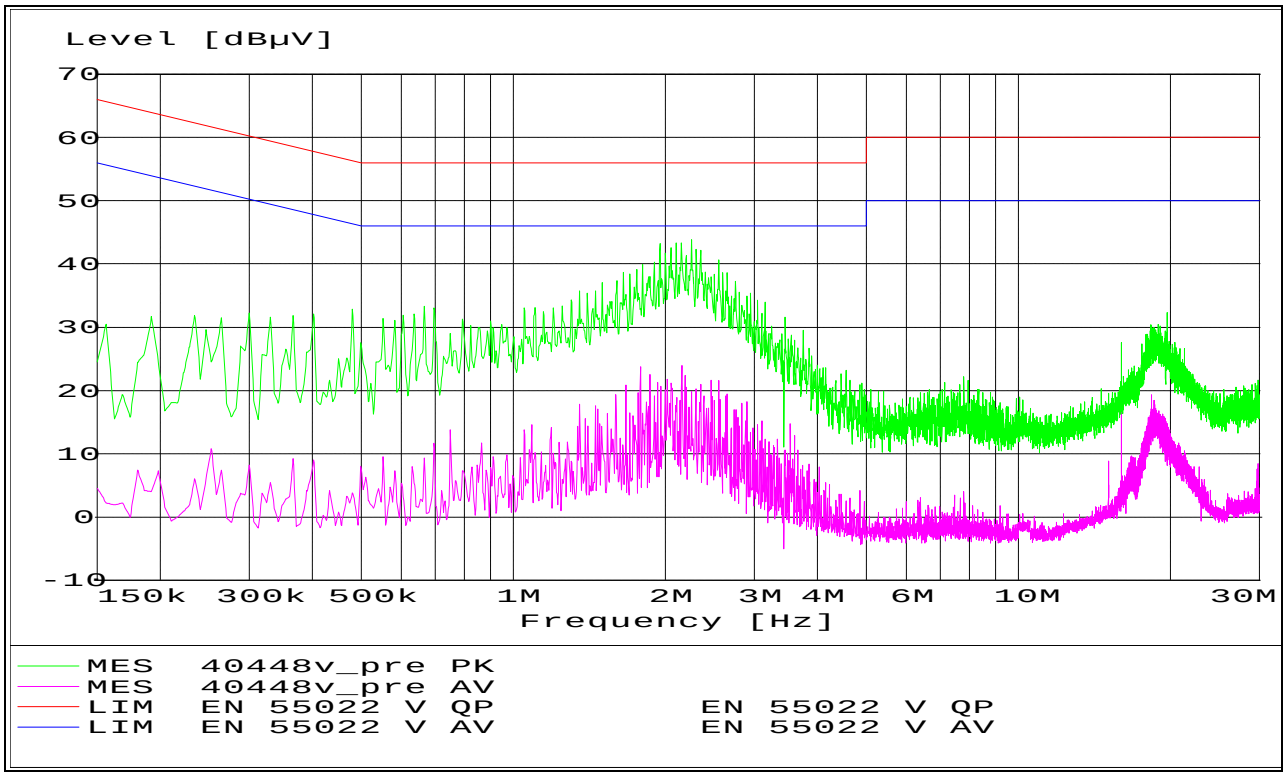
5.1 CONDUCTED EMISSION TEST (150 kHz to 30 MHz)

Ambient temperature	20 °C	Relative humidity	45 %

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 of this test report.

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



Data record name: 40448v of 17 May 2004

Test: Passed

TEST EQUIPMENT USED THE TEST:

1, 2, 3, 5, 6

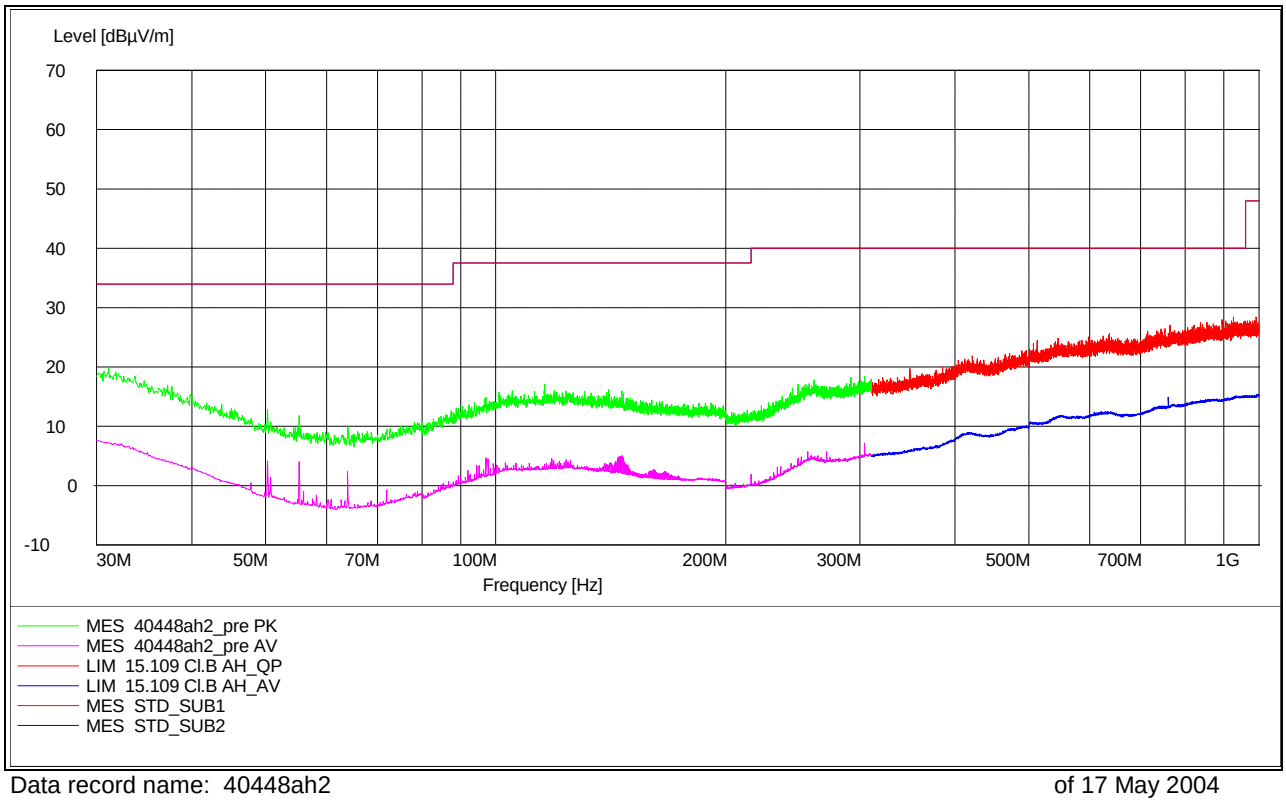
5.2 PRELIMINARY RADIATED MEASUREMENT (30 MHz to 1 GHz)

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. The distance between EUT and antenna was 3 m.

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

Test record: The test was carried out in normal operation-mode.



Data record name: 40448ah2 of 17 May 2004

The following significant frequencies were found during the preliminary radiated test:

50.240 MHz, 55.280 MHz, 72.000 MHz

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 35

5.3 FINAL RADIATED EMISSION TEST (30 MHz to 1 GHz)

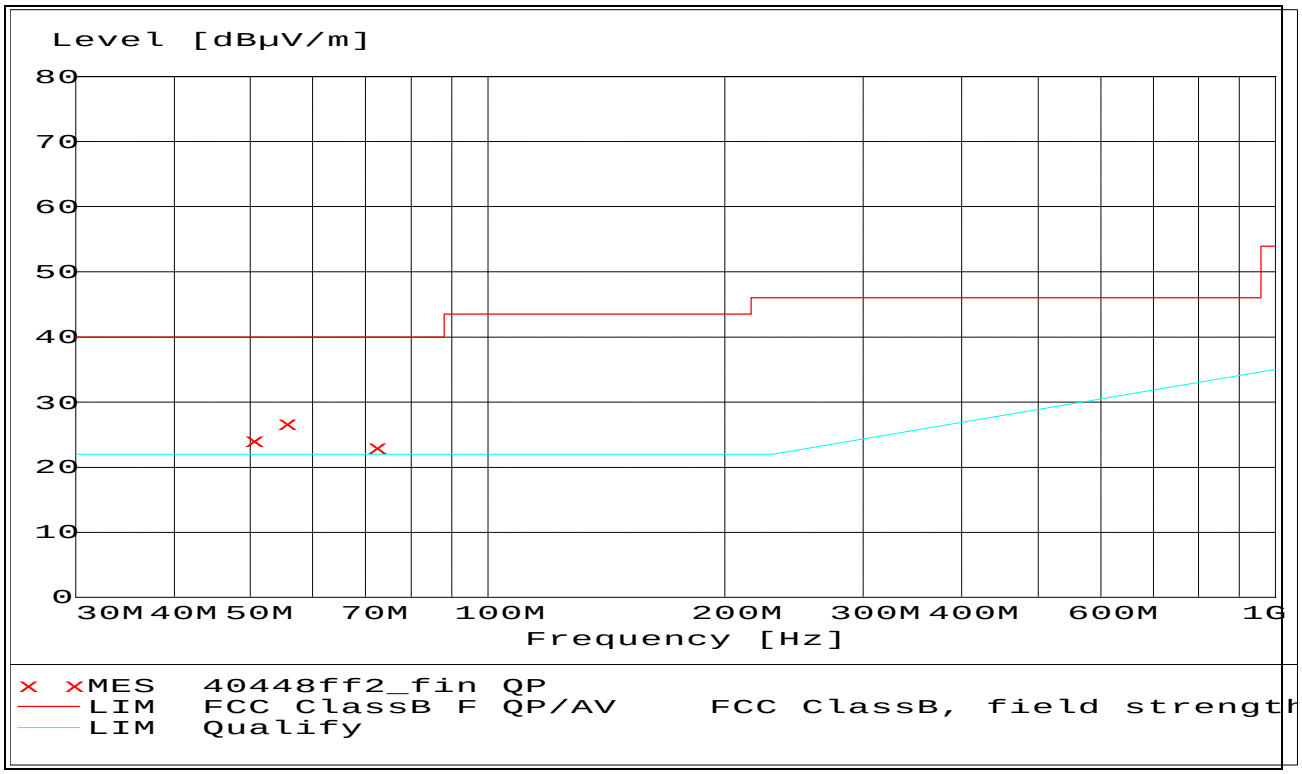
Ambient temperature	19 °C	Relative humidity	55 %

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

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

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

The measured points and the limit line in the following diagram refer to the standard measurement of the emitted interference in compliance with the above-mentioned standard. The measured points marked with x are the measured results of the standard final measurement on the open area test site.



Data record name: 40448ff2 of 18 May 2004

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 3 m 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
50.240000	24.10	9.7	40.0	15.9	180.0	194.00	VERTICAL
55.280000	26.60	7.7	40.0	13.4	275.0	202.00	VERTICAL
72.000000	23.00	7.7	40.0	17.0	316.0	67.00	HORIZONTAL

Data record name: 40448ff2_fin QP of 18 May 2004

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:

14 – 20

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	Standard Gain Horn 11.9GHz – 18GHZ	18240-20	Flann Microwave	483	480294
38	Standard Gain Horn 11.9GHz – 18GHZ	18240-20	Flann Microwave	482	480295

39	Standard Gain Horn 17.9GHz – 26.7GHZ	20240-20	Flann Microwave	411	480297
40	Standard Gain Horn 17.9GHz – 26.7GHZ	20240-20	Flann Microwave	410	480296
41	Standard Gain Horn 26.4GHz – 40.1GHZ	22240-20	Flann Microwave	469	480299
42	Standard Gain Horn 26.4GHz – 40.1GHZ	22240-20	Flann Microwave	468	480298
43	RF-cable No. 30	RTK 081	Rosenberger	-	410141
44	RF-cable No. 31	RTK 081	Rosenberger	-	410142
45	RF-cable 1m	KPS-1533-400-KPS	Insulated Wire	-	480300
46	RF-cable 1m	KPS-1533-400-KPS	Insulated Wire	-	480301
47	RF-cable 2m	KPS-1533-400-KPS	Insulated Wire	-	480302
48	RF-cable No. 5	RTK 081	Rosenberger		410097
49	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337
50	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343
51	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342
52	Preamplifier	JS3-26004000-25-5A	Miteq	563593	480344
53	EMI Software	ES-K1	Rohde & Schwarz	-	480111

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

7 LIST OF ANNEXES

ANNEX A	**PHOTOGRAPHS OF THE TEST SET-UPS**:	**3 pages**
	Test set-up preliminary radiated emission measurement 30 MHz to 1 GHz	40458emi1.jpg
	Test set-up final radiated emission measurement 30 MHz to 1 GHz	40458emi19.jpg
	Test set-up conducted emission measurement	40458emi18.jpg
ANNEX B	**EXTERNAL PHOTOGRAPHS OF THE TEST SAMPLE**:	**2 pages**
	EUT, TSS/SG-G3/2 front view	40458eut31.jpg
	EUT, TSS/DA3P front view	40458eut15.jpg
ANNEX C	**INTERNAL PHOTOGRAPHS OF THE TEST SAMPLE**:	**4 pages**
	TSS/SG-G3/2 PCB front view	40458eut7.jpg
	TSS/SG-G3/2 PCB rear view	40458eut4.jpg
	TSS/DA3P: PCB front view	40458eut12.jpg
	TSS/DA3P: PCB rear view	40458eut14.jpg