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TEST REPORT

Test Report Reference: R40458/1 Edition 2

Equipment under Test: TSS/TS

Serial Number: 10001175

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

Phoenix TEST-LAB GmbH
Königswinkel 10
32825 Blomberg
Tel. 0 52 35 / 95 00-0
Fax 0 52 35 / 95 00-10

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 C63.4-2001** 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 (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:	125 kHz short range trigger device for tire pressure monitoring system
Type designation:	TSS/TS
Serial No.:	10001175
Highest internal frequency:	5 MHz (internal clock 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 the control device TSS/SG-G3/2 and powered with an external power supply.

2.3 MODIFICATIONS

No modifications necessary to fulfil the requirements.

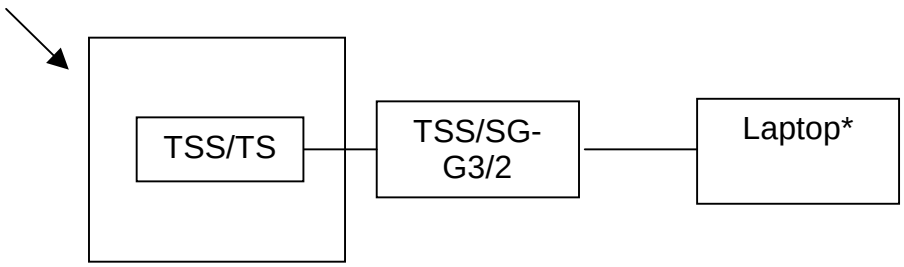
3 OPERATIONAL STATES AND PHYSICAL BOUNDARIES

The transmitter was tested in normal operation mode:

Channel:	Transmit frequency:
1	125.000 kHz

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). Vector Tool “CANape” to stimulate the EUT TSS/TS.

4 LIST OF TEST MODULES

4.1 EMISSION

Radiated emissions FCC 47 CFR Part 15 section 15.209 [2]						
No.	Application	Frequency range	Limits (microvolts/meter)	Reference standard	Remark	Status
1	Intentional radiator	0.009 to 0.49 MHz 0.490 to 1.705 MHz 1.705 to 30.0 MHz 30 to 88 MHz 88 to 216 MHz 216 to 960 MHz 960 to 1000 MHz	2400/f(kHz) at 300 m 24000/f(kHz) at 30 m 30 dBµV/m at 30 m 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 C63.4 (2001);	-	Passed

METHOD OF MEASUREMENT

4.2 RADIATED EMISSIONS 9 kHz to 30 MHz

The radiated emission measurement is divided into two stages.

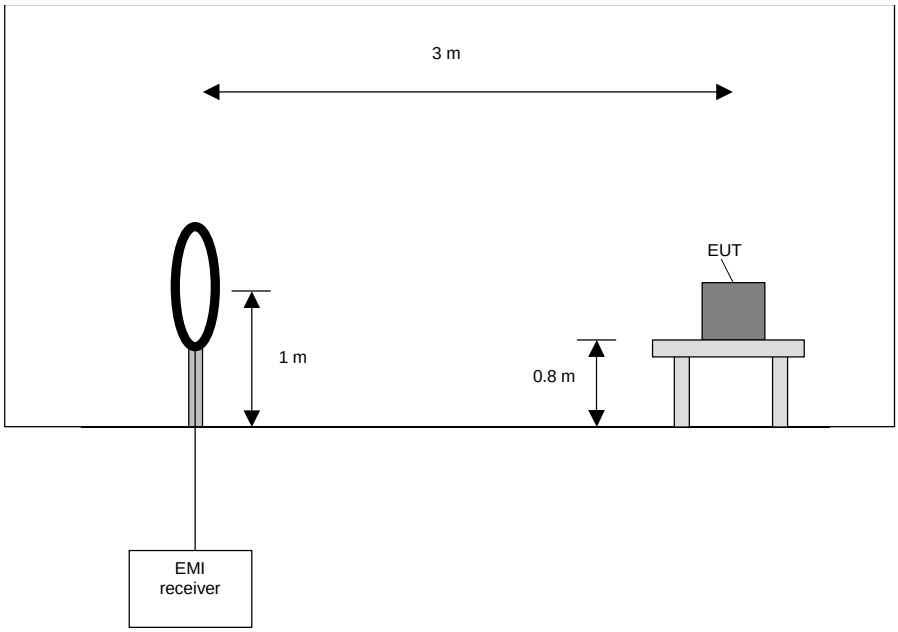
Preliminary measurement:

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. 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 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to found the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Preliminary measurement procedure:

Prescans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

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 frequencies of highest detected emission 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 of the EUT if applicable (handheld equipment).
7) Rotate the measuring antenna and repeat steps 1) to 5).

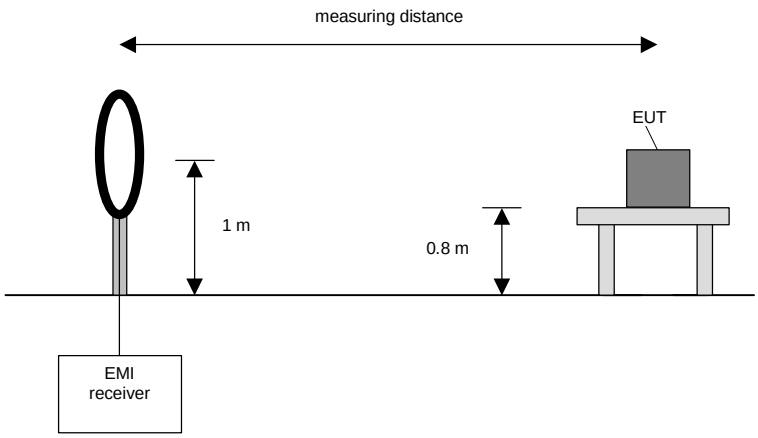
Final measurement:

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m and 30 m. In the case where larger measuring distances are required the results will be extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with a EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according Section 15.209 (d) [2].

On the during the preliminary measurement detected frequencies the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

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

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



Final measurement procedure:

The following procedure will be used:

1) Monitor the frequency range with the measuring antenna at vertical orientation parallel to the EUT at an azimuth of 0 °.
2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
3) Rotate the measuring antenna to find the maximum and note the value.
4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
5) Repeat steps 1) to 4) with the other orthogonal axes of the EUT if applicable (handheld equipment).

4.3 RADIATED EMISSIONS 30 MHz TO 1 GHz

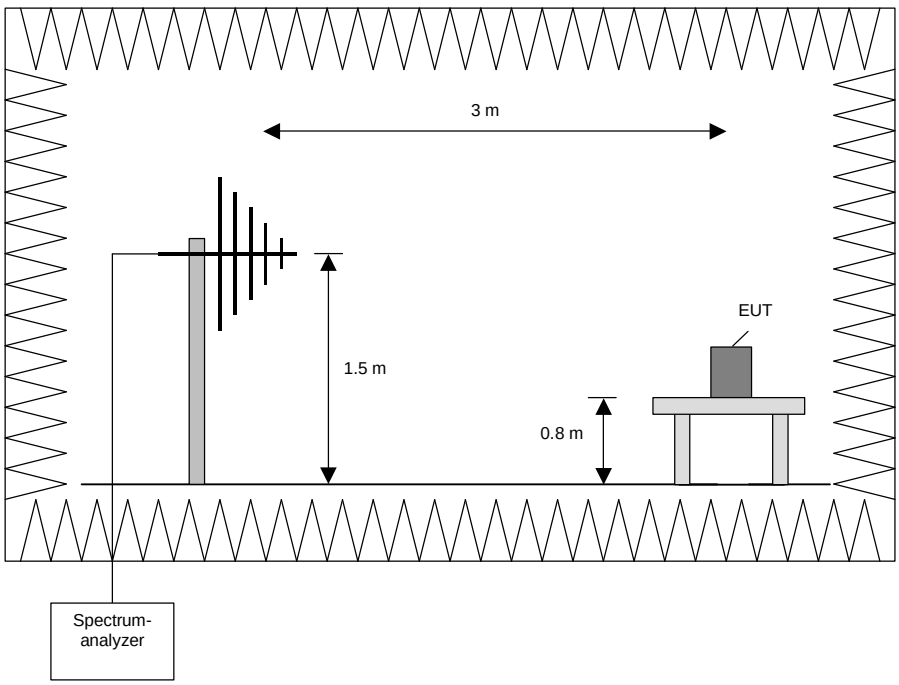
The radiated emission measurement is divided into two stages.

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 100 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 °.

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

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.
The following procedure will be used:

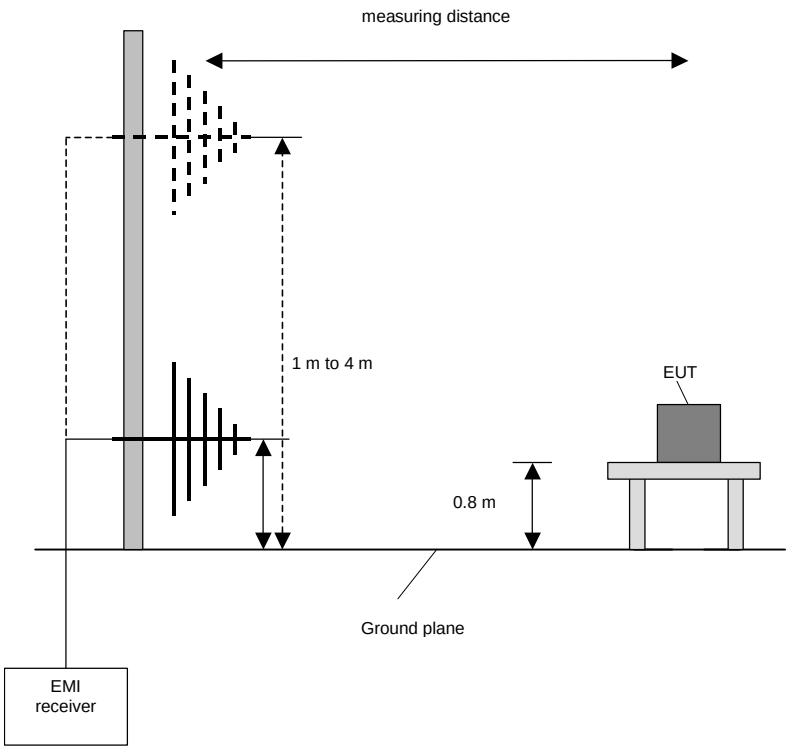
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °
2. Manipulate the system cables within the range to produce the maximum level of emission
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum
5. Measure the frequency of 3 highest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

Final Measurement:

In the second stage a final measurement on an open area test site will be performed on selected frequencies found in the preliminary measurement. During this test the EUT will be rotated 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 resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure 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 if handheld equipment

5 TEST RESULTS EMISSION TEST

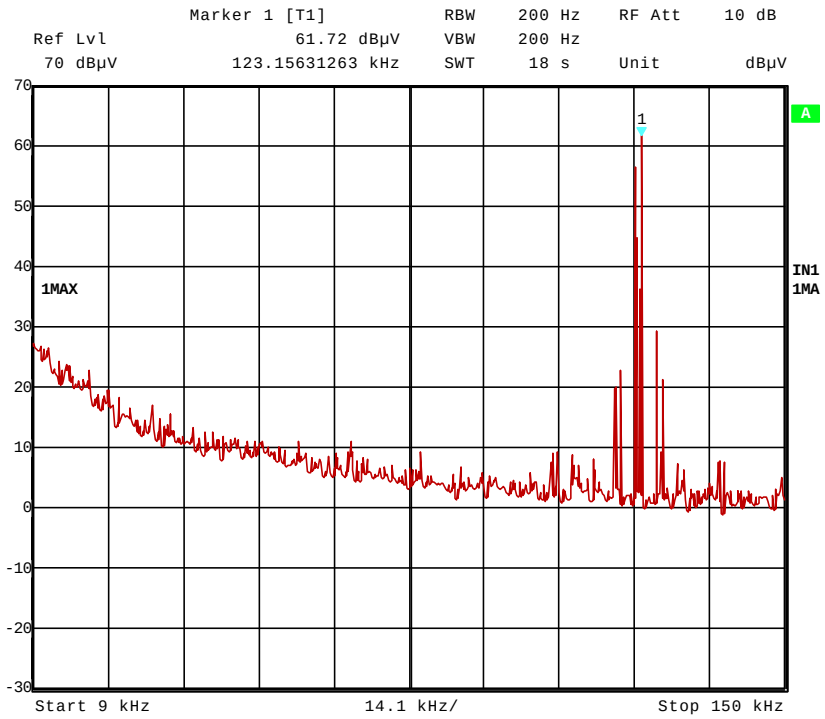
5.1 PRELIMINARY RADIATED EMISSION TEST (9 kHz TO 30 MHz)

Ambient temperature	20 °C	Relative humidity	65 %

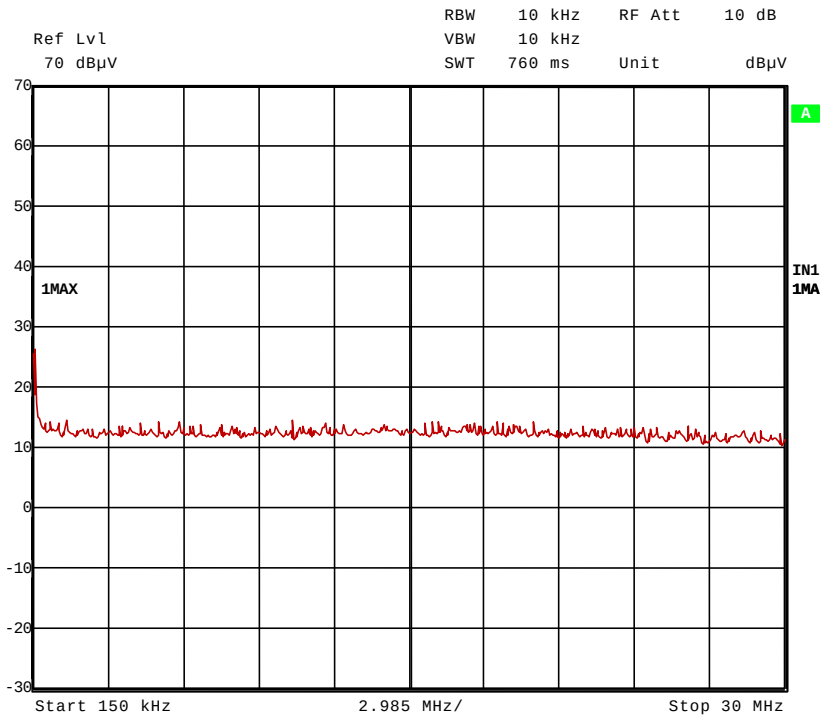
Position of EUT: The EUT was set-up on a wooden table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

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 of the EUT (transmit mode). All results are shown in the following.



30448tx12.wmf: 9 kHz to 150 kHz, transmit mode



30448tx21mf: 150 kHz to 30 MHz, transmit mode

The following significant frequency was found during the preliminary radiated emission test:

123.156 kHz

These frequencies have to be measured on the outdoor test site. The results of this final measurement are shown in this test report.

TEST EQUIPMENT USED THE TEST:

29, 31 - 33, 41, 42

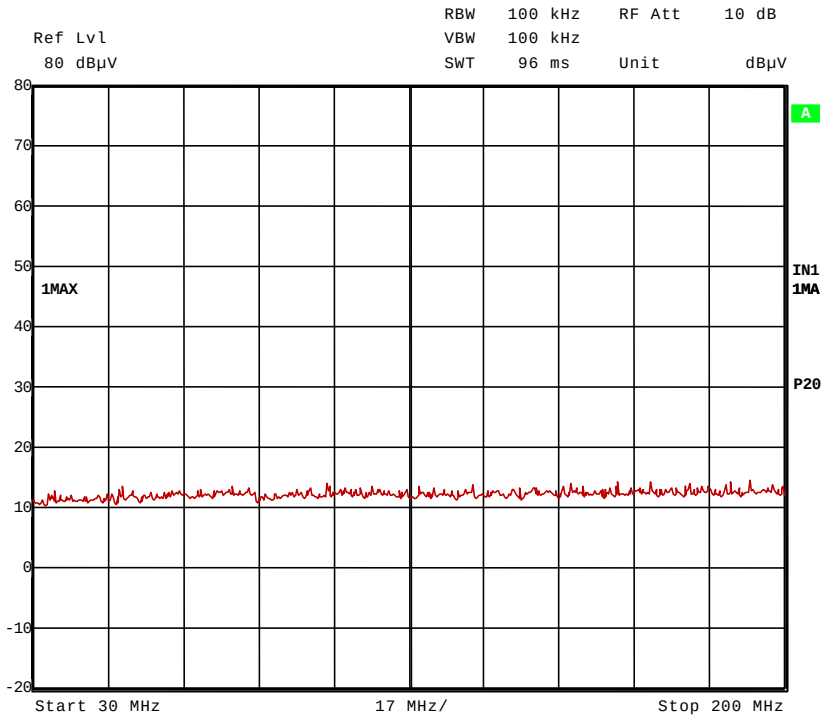
5.2 PRELIMINARY RADIATED EMISSION TEST (30 MHz to 1 GHz)

Ambient temperature	20 °C	Relative humidity	60 %

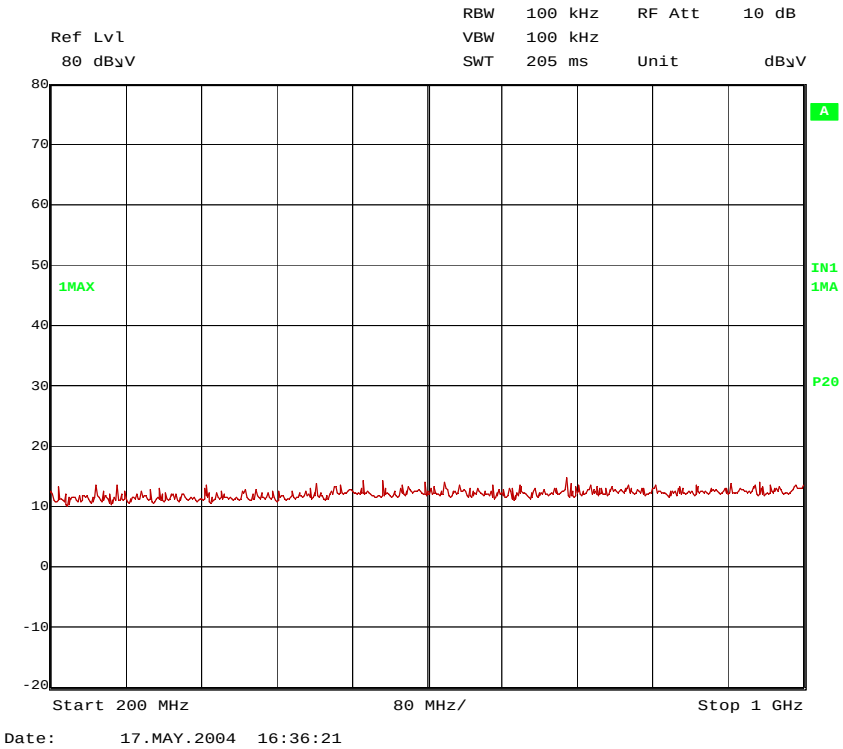
Position of EUT: The EUT was set-up on a wooden table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

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 of the EUT (transmit mode). All results are shown in the following.



30448tx3a.wmf: 30 MHz to 200 MHz, transmit mode



30448tx4a.wmf: 200 MHz to 1000 MHz, transmit mode

No significant frequencies were found during the preliminary radiated emission test:

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 35, 37, 42

5.3 FINAL RADIATED EMISSION TEST (9 kHz TO 30 MHz)

Ambient temperature	20 °C	Relative humidity	60 %

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 of the EUT (transmit mode). All results are shown in the following.

Limits: To calculate the limits according to the used measuring distance, the 40 dB/decade extrapolation method was used.

Supply voltage: For measuring the amplitude of the fundamental frequency the supply voltage was varied from 9 V DC to 16 V DC. There was no changing of the amplitude for these supply voltages measurable. So the EUT was supplied with 12 V DC.

Test results: The test results were calculated with the following formula:

Result [dBµV/m] = reading [dBµV] + antenna factor [dB/m]

Measuring results (distance 3 m):

Fundamental frequency						
Frequency kHz	Result dBµV/m	Limit dBµV/m	Margin dB	Detector	Readings dBµV	Antenna factor * dB/m
121.800	62.5	105.5	43.0	QP	42.5	20

*: Cable loss included

Test: Passed

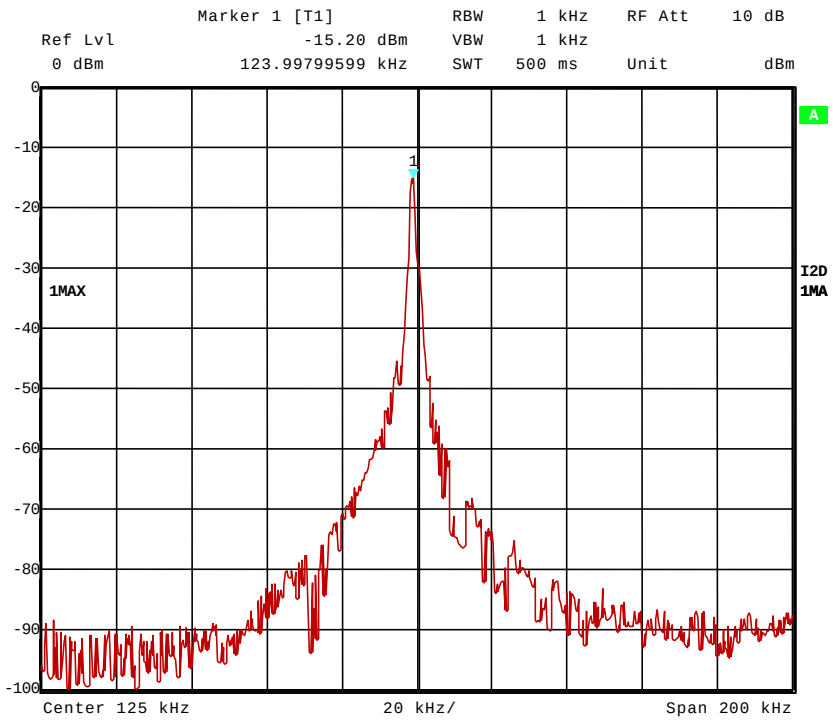
TEST EQUIPMENT USED FOR THE TEST:

40 - 43

5.4 BAND EDGE COMPLIANCE

Ambient temperature:	20 °C	Relative humidity:	62 %

Supply voltage: For measuring the amplitude of the fundamental frequency the supply voltage was varied from 9 V DC to 16 V DC. There was no changing of the amplitude for these supply voltages measurable. So the EUT was supplied with 12 V DC.



40448tx6.wmf: Occupied bandwidth

F_L	F_U	BW (F_U - F_L)
121.850 kHz	125.120 kHz	3.27 kHz

Test: Passed

TEST EQUIPMENT USED THE TEST:

29, 31, 41, 42, 44, 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	EMI test receiver	ESPC	Rohde & Schwarz	843756/006	480150

44	Signal generator	SMHU	Rohde & Schwarz	844170/017	480266
45	Climatic chamber	GTS500.40	GTS	1660	490073
46	Loop Antenna ∅ = 225 mm	-	Phoenix Test-Lab	-	410085
47	RF-cable No. 11	RG223	Phoenix-Test-Lab	-	410103
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

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 emission measurement (9 kHz to 30 MHz)	40458emi8.jpg
	Test set-up preliminary emission measurement (30 MHz to 1 GHz)	40458emi17.jpg
	Test set-up final emission measurement (9 kHz to 30 MHz)	40458emi22.jpg
ANNEX B	**EXTERNAL PHOTOGRAPHS OF THE TEST SAMPLE**:	**1 pages**
	EUT, front view	40458eut2.jpg
ANNEX C	**INTERNAL PHOTOGRAPHS OF THE TEST SAMPLE**:	**2 pages**
	EUT, PCB front view	40458eut18.jpg
	EUT, PCB rear view	40458eut20.jpg