



EMI -- TEST REPORT

Test Report No. :	T25797-00-02AA	02. June 2005 Date of issue
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Type / Model Name : SML G1, SML S1, SML E1, SML W1

Product Description : Marker Locator

Applicant : TÜV Product Service Slovakia s.r.o.

Address : 01331 DIVINA 595, Slowakei

Manufacturer : Ing. Stefan SIVAK, KOMPLEX

Address : Tatranska 3

01008 Zilina, Slovakia

Licence holder : Ing. Stefan SIVAK, KOMPLEX

Address : Tatranska 3

01008 Zilina, Slovakia

Test Result according to the standards listed in clause 1 test standards:	POSITIVE
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The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15 Subpart C- Intentional Radiators (October 01, 2003)

Part 15, Subpart C, Section 15.209(a) Radiated emissions, general requirements



2 SUMMARY

GENERAL REMARKS:

The tests have been carried out in conjunction with 4 different antennas. The following antennas are spezified for different fundamental frequencies:

- SML G1: 83.0 kHz
- SML S1: 121.6 kHz
- SML E1: 134.0 kHz
- SML W1: 145.7 kHz

FINAL ASSESSMENT:

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records of MBPS

Testing commenced on : 16. March 2005

Testing concluded on : 17. March 2005

Checked by:



Harald Buchwald
Ich bestätige die
Richtigkeit und Integrität
dieses Dokuments
2005.06.02 16:29:56
+02'00'

Harald Buchwald
Dipl. Ing.(FH)

Tested by:



Anton Altmann
Ich bin der Verfasser
dieses Dokuments
2005.06.02 16:22:21
+02'00'

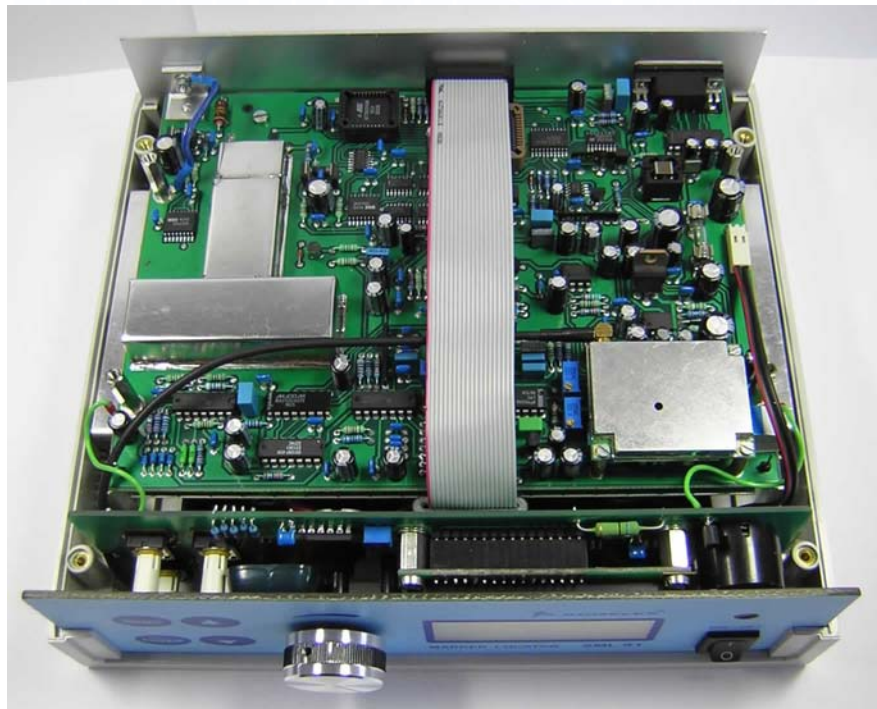
Anton Altmann
Dipl. Ing.(FH)

3 EQUIPMENT UNDER TEST

3.1 Photo documentation of the EuT

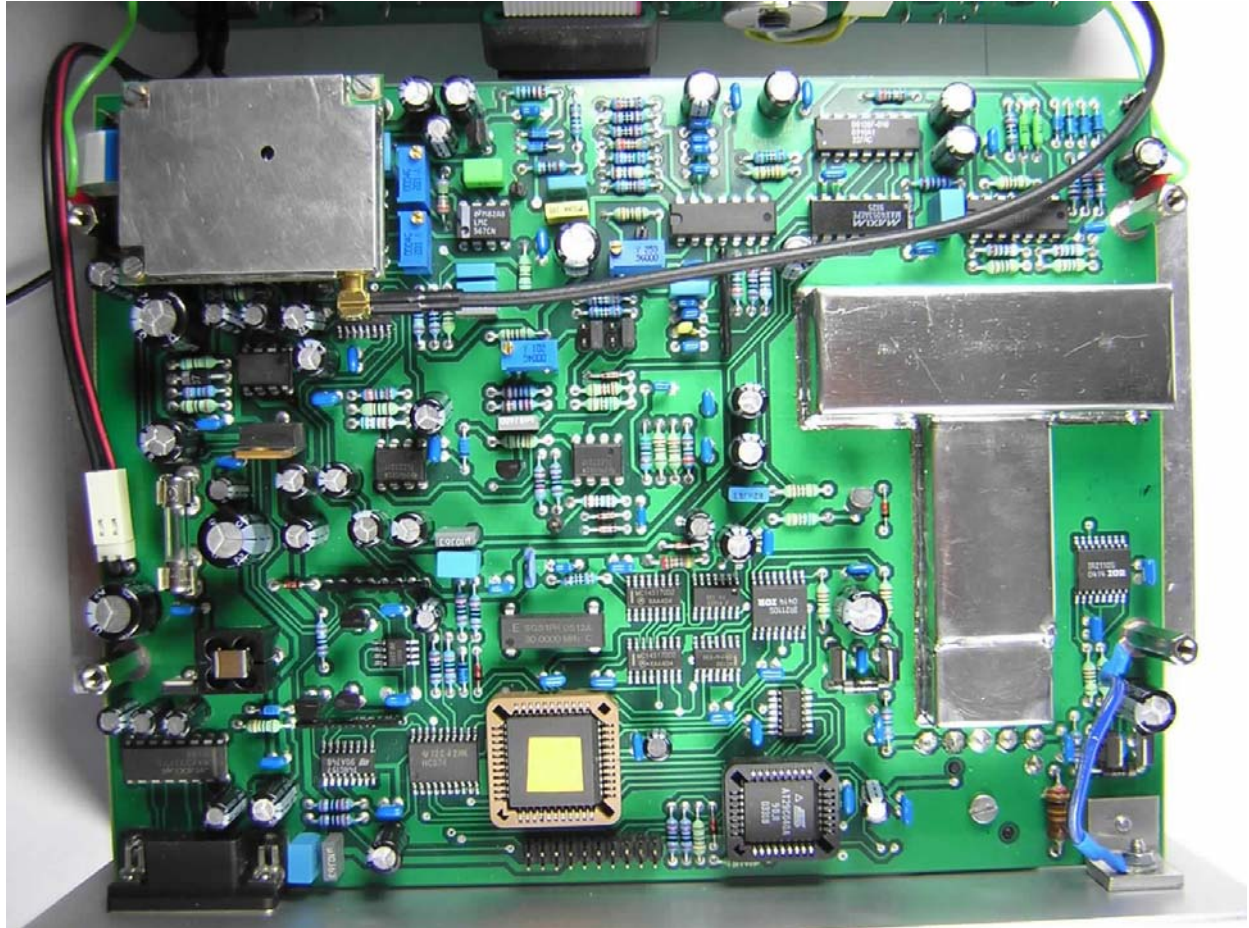


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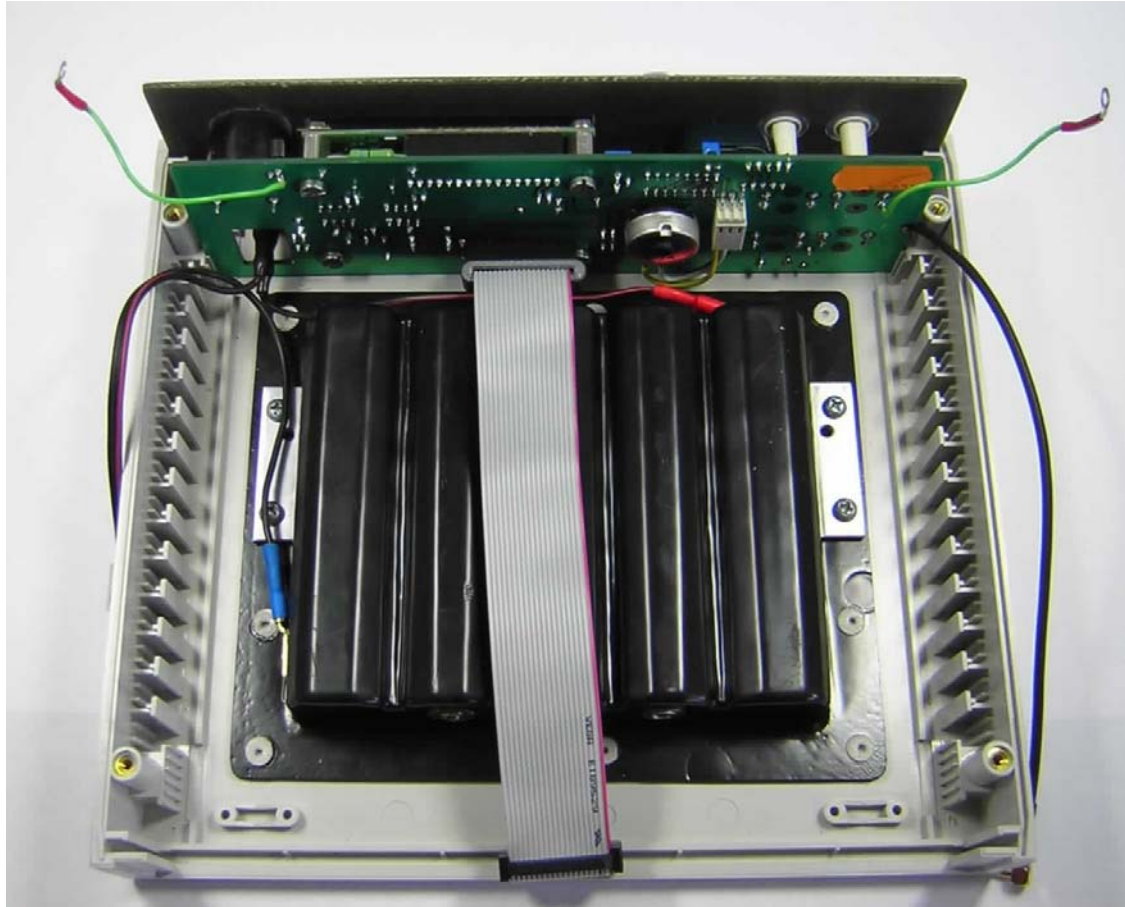
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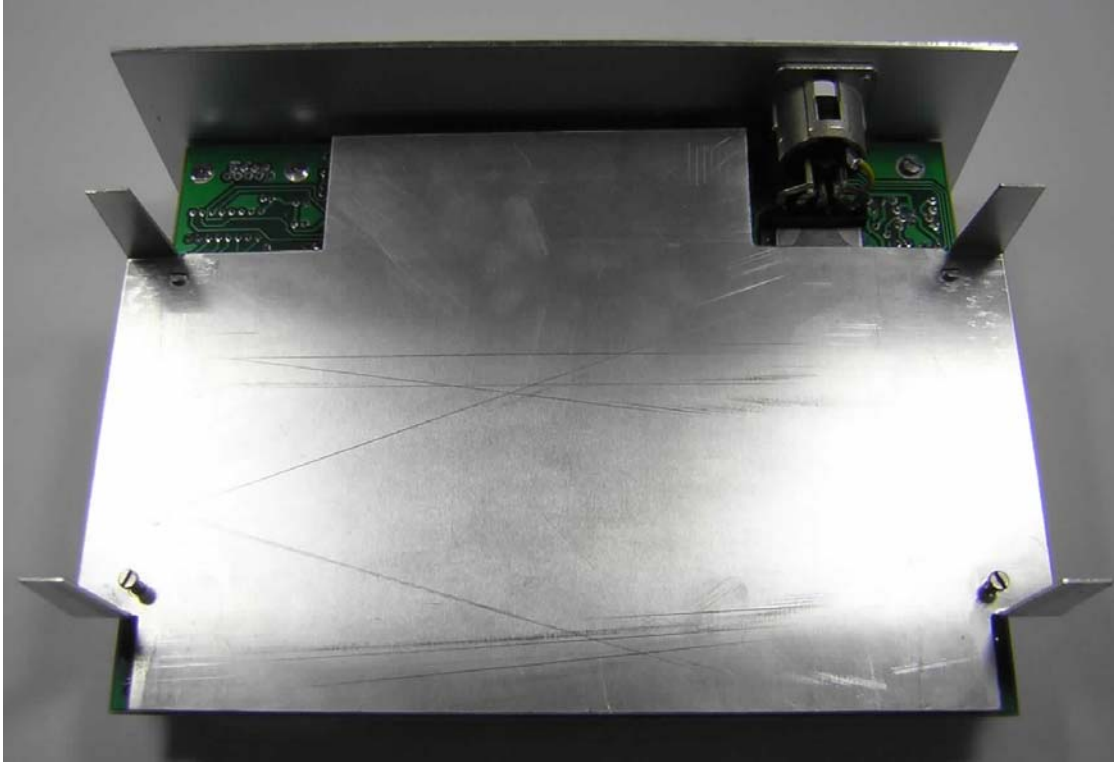
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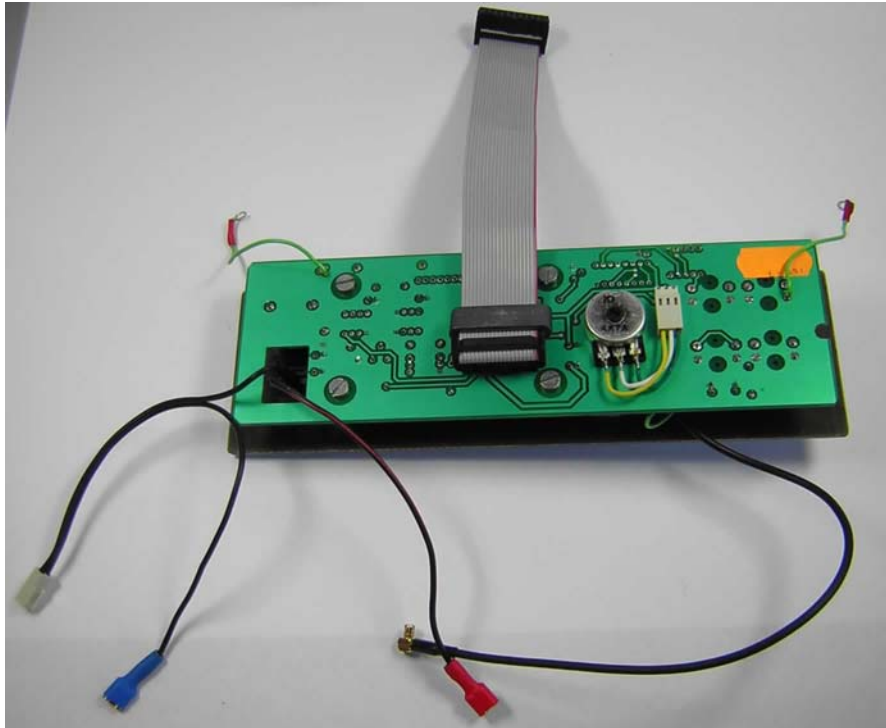


FCC ID: TBF-SML



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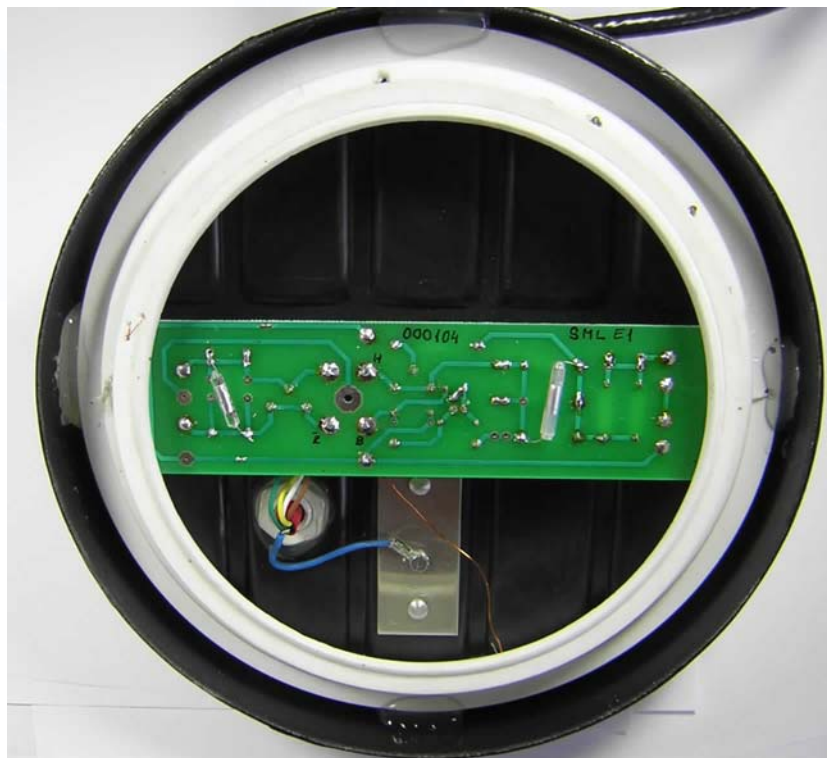
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3.2 Power supply system utilised

Power supply voltage : 13 V / DC

3.3 Short description of the Equipment under Test (EuT)

The EuT Smart Marker Locator (SML) can be used to marking and identification of underground devices (water and gas pipes, telecommunication and power cables etc.). It can be manufactured for several frequencies depending on required application. The EuT has built in a GPS receiver module and a GPS antenna. All data are stored into flash memory and can be uploaded to a PC via RS232 cable.

Number of tested samples: 1 in conjunction with 4 different antennas
Serial number: 00104

EuT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- Marker detection mode

EuT configuration:

(The CDF filled by the applicant can be viewed at the test laboratory.)

The following peripheral devices and interface cables were connected during the measurements:

- Antenna cable	Customer specific
- Serial RS 232 cable	
-	
-	

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

**MIKES BABT Product Service GmbH
Ohmstrasse 2-4
94342 Strasskirchen
Germany**

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 ° C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 /11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the MIKES BABT Product Service GmbH quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.4 Measurement Protocol for FCC, VCCI and AUSTEL

4.4.1 GENERAL INFORMATION

4.4.1.1 Test Methodology

Conducted and radiated disturbance testing is performed according to the procedures in International Special Committee on Radio Interference (CISPR) Publication 22 (1997), European Standard EN 55022 and Australian Standard AS 3548 (which are based on CISPR 22).

The Japanese standard, "Voluntary Control Council for Interference (VCCI) by Data Processing Equipment and Electronic Office Machines, Technical Requirements" is technically equivalent to CISPR 22 (1997). For official compliance, a conformance report must be sent to and accepted by the VCCI.

In compliance with FCC Docket 92-152, "Harmonization of Rules for Digital Devices Incorporate International Standards", testing for FCC compliance may be done following the ANSI C63.4-2003 procedures and using the CISPR 22 Limits.

4.4.1.2 Measurement Error

The data and results referenced in this document are true and accurate. The reader is cautioned that there is some measurement variability due to the tolerances of the test equipment that can contribute to a nominal product measurement uncertainty. The measurement uncertainty was calculated for all measurements listed in this test report according to NIS 81/5.1994 "The treatment of uncertainty in EMC measurements" and is documented in the MIKES BABT Product Service GmbH quality system according to DIN EN ISO/IEC 17025. Furthermore, component differences and manufacturing process variability of production units similar to that tested may result in additional product uncertainty. If necessary, refer to the test lab for the actual measurement uncertainty for specific tests. The manufacturer has the sole responsibility of continued compliance of the device.

4.4.1.3 Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into it's characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum disturbances from the unit.

4.4.2 DETAILS OF TEST PROCEDURES

General Standard Information

The test methods used comply with CISPR Publication 22 (1997), EN 55022 (2001) and AS 3548 (1992) - "Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment" and with ANSI C63.4-2003 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

5 TEST CONDITIONS AND RESULTS

5.1 Conducted emissions

For test instruments and accessories used see section 6 Part.

5.1.1 Description of the test location

Test location:

5.1.2 Photo documentation of the test set-up

5.1.3 Description of Measurement

The final level, expressed in dB μ V, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC Limit or to the CISPR limit, which is equivalent to the Australian AS 3548 limit.

To convert between dB μ V and μ V, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EuT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection, and a Line Impedance Stabilization Network (LISN), with 50 Ω /50 μ H (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeter's above the floor and is positioned 40 centimeter's from the vertical ground plane (wall) of the screen room. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

5.1.4 Test result

Frequency range:

Min. limit margin

Remarks: The measurement is not applicable. The EuT is battery powered.

5.2 Field strength of the fundamental wave

For test instruments and accessories used see section 6 Part CPR 1.

5.2.1 Description of the test location

Test location: OATS1

Test distance: 30 metres

5.2.2 Photo documentation of the test set-up



5.2.3 Description of Measurement

The magnetic field strength from the EuT is measured in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna. The antenna was positioned 3, 10 or 30 meters horizontally from the EuT. Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions.

The final level, expressed in dB μ V/m, is arrived at by taking the reading from the EMI receiver (Level dB μ V) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has to be compared with the relevant FCC limit.

The resolution bandwidth during the measurement is as follows:

9 kHz – 150 kHz: ResBW: 200 Hz

150 kHz – 30 MHz: ResBW: 9 kHz

Example:

Frequency (MHz)	Level (dB μ V)	+	Factor (dB)	=	Level (dB μ V/m)	Limit (dB μ V/m)	=	Delta (dB)
1.705	5	+	20	=	25	30	=	5

5.2.4 Test result

a) SML G1

Measurement distance: 30m

Frequency [MHz]	L: PK [dB μ V]	L: AV [dB μ V]	L: QP [dB μ V]	Correct. [dB]	L: PK [dB μ V/m]	L: AV [dB μ V/m]	L: QP [dB μ V/m]	Limit [dB μ V/m]	Delta [dB]
0.083		21.8		20.0		41.8		69.2	27.4

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dB μ V]	L: AV [dB μ V]	L: QP [dB μ V]	Correct. [dB]	L: PK [dB μ V/m]	L: AV [dB μ V/m]	L: QP [dB μ V/m]	Limit [dB μ V/m]	Delta [dB]
0.083		-18.2		20		1.8		29.2	27.4

d) SML S1

Measurement distance: 30m

Frequency [MHz]	L: PK [dB μ V]	L: AV [dB μ V]	L: QP [dB μ V]	Correct. [dB]	L: PK [dB μ V/m]	L: AV [dB μ V/m]	L: QP [dB μ V/m]	Limit [dB μ V/m]	Delta [dB]
0.1218		19.4		20.0		39.4		65.9	26.5

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dB μ V]	L: AV [dB μ V]	L: QP [dB μ V]	Correct. [dB]	L: PK [dB μ V/m]	L: AV [dB μ V/m]	L: QP [dB μ V/m]	Limit [dB μ V/m]	Delta [dB]
0.1218		-20.6		20		-0.6		25.9	26.5

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c) SML E1

Measurement distance: 30m

Frequency [MHz]	L: PK [dBμV]	L: AV [dBμV]	L: QP [dBμV]	Correct. [dB]	L: PK [dBμV/m]	L: AV [dBμV/m]	L: QP [dBμV/m]	Limit [dBμV/m]	Delta [dB]
0.1339		19.7		20.0		39.7		65.1	25.4

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dBμV]	L: AV [dBμV]	L: QP [dBμV]	Correct. [dB]	L: PK [dBμV/m]	L: AV [dBμV/m]	L: QP [dBμV/m]	Limit [dBμV/m]	Delta [dB]
0.1339		-20.3		20		-0.3		25.1	25.4

d) SML W1

Measurement distance: 30m

Frequency [MHz]	L: PK [dBμV]	L: AV [dBμV]	L: QP [dBμV]	Correct. [dB]	L: PK [dBμV/m]	L: AV [dBμV/m]	L: QP [dBμV/m]	Limit [dBμV/m]	Delta [dB]
0.1458		17.7		20.0		37.7		64.3	26.6

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dBμV]	L: AV [dBμV]	L: QP [dBμV]	Correct. [dB]	L: PK [dBμV/m]	L: AV [dBμV/m]	L: QP [dBμV/m]	Limit [dBμV/m]	Delta [dB]
0.1458		-22.3		20		-2.3		24.3	26.6

Limit according to FCC Part 15 Subpart 15.209(a)

Frequency (MHz)	Field strength of fundamental wave		Measurement distance (meters)
	(μV/m)	dB (μV/m)	
0.009-0.490	2400/F(kHz)	--	300
0.490-1.705	24000/F (kHz)	--	30
1.705-30.0	30	29.5	30

The requirements are **FULFILLED**.

Remarks: _____

5.3 Spurious emissions (Magnetic field) 9 kHz – 30 MHz

For test instruments and accessories used see section 6 Part SER 1.

5.3.1 Description of the test location

Test location: OATS1

Test distance: 30 metres

5.3.2 Photo documentation of the test set-up



5.3.3 Description of Measurement

Spurious emissions from the EuT are measured in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna. The antenna was positioned 3, 10 or 30 meters horizontally from the EuT. Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions.

The final level, expressed in dB μ V/m, is arrived at by taking the reading from the EMI receiver (Level dB μ V) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has to be compared with the relevant FCC limit.

The resolution bandwidth during the measurement is as follows:

9 kHz – 150 kHz: ResBW: 200 Hz

150 kHz – 30 MHz: ResBW: 9 kHz

Example:

Frequency (MHz)	Level (dB μ V)	+	Factor (dB)	=	Level (dB μ V/m)	Limit (dB μ V/m)	=	Delta (dB)
1.705	5	+	20	=	25	30	=	5

5.3.4 Test result

SML G1

SML S1

SML E1

SML W1

Measurement distance: 30m

Frequency [MHz]	L: PK [dB μ V]	L: AV [dB μ V]	L: QP [dB μ V]	Correct. [dB]	L: PK [dB μ V/m]	L: AV [dB μ V/m]	L: QP [dB μ V/m]	Limit [dB μ V/m]	Delta [dB]
0.009-30.0	---	---	---						

Remarks: No spurious emissions could be measured.

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dB μ V]	L: AV [dB μ V]	L: QP [dB μ V]	Correct. [dB]	L: PK [dB μ V/m]	L: AV [dB μ V/m]	L: QP [dB μ V/m]	Limit [dB μ V/m]	Delta [dB]

Limit according to FCC Part 15 Subpart 15.209(a)

Frequency (MHz)	Field strength of spurious emissions		Measurement distance (meters)
	(μ V/m)	dB (μ V/m)	
0.009-0.490	2400/F(kHz)	--	300
0.490-1.705	24000/F (kHz)	--	30
1.705-30.0	30	29.5	30

The requirements are **FULFILLED**.

Remarks: All unwanted emissions are below -15 dB μ V/m (at 300 m).

5.4 Radiated emissions (electric field) 30 MHz – 1 GHz

For test instruments and accessories used see section 6 Part SER 2.

5.4.1 Description of the test location

Test location: OATS1

Test distance: 10 metres

5.4.2 Photo documentation of the test set-up



5.4.3 Description of Measurement

Spurious emissions from the EuT are measured in the frequency range of 30 MHz to 10 times the highest used frequency using a tuned receiver and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna was positioned 3, 10 or 30 meters horizontally from the EuT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarization`s and the EuT are rotated 360 degrees.

The final level, expressed in dB μ V/m, is arrived by taking the reading from the EMI receiver (Level dB μ V) and adding the correction factors and cable loss factor (Factor dB) to it. This is done automatically in the EMI receiver, where the correction factors are stored. This result then has the FCC or CISPR limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets at page.

Example:

Frequency (MHz)	Level (dB μ V)	+	Factor (dB)	=	Level (dB μ V/m)	Limit (dB μ V/m)	=	Delta (dB)
719	75	+	32.6	=	107.6	110	=	-2.4

5.4.4 Test result

SML G1
SML S1
SML E1
SML W1

Measurement distance: 10 m

Frequency [MHz]	L: PK [dBμV]	L: AV [dBμV]	L: QP [dBμV]	Correct. [dB]	L: PK [dBμV/m]	L: AV [dBμV/m]	L: QP [dBμV/m]	Limit [dBμV/m]	Delta [dB]
30-1000	---	---	---						

Remarks: No spurious emissions could be measured.

Limit according to FCC Part 15 Subpart 15.209(a)

Frequency (MHz)	Field strength of spurious emissions		Measurement distance (meters)
	(μV/m)	dB (μV/m)	
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
960-1000	500	54	3

The requirements are **FULFILLED**.

Remarks: All unwanted emissions are below 5 dBμV/m (at 3 m).

5.5 Emission Bandwidth

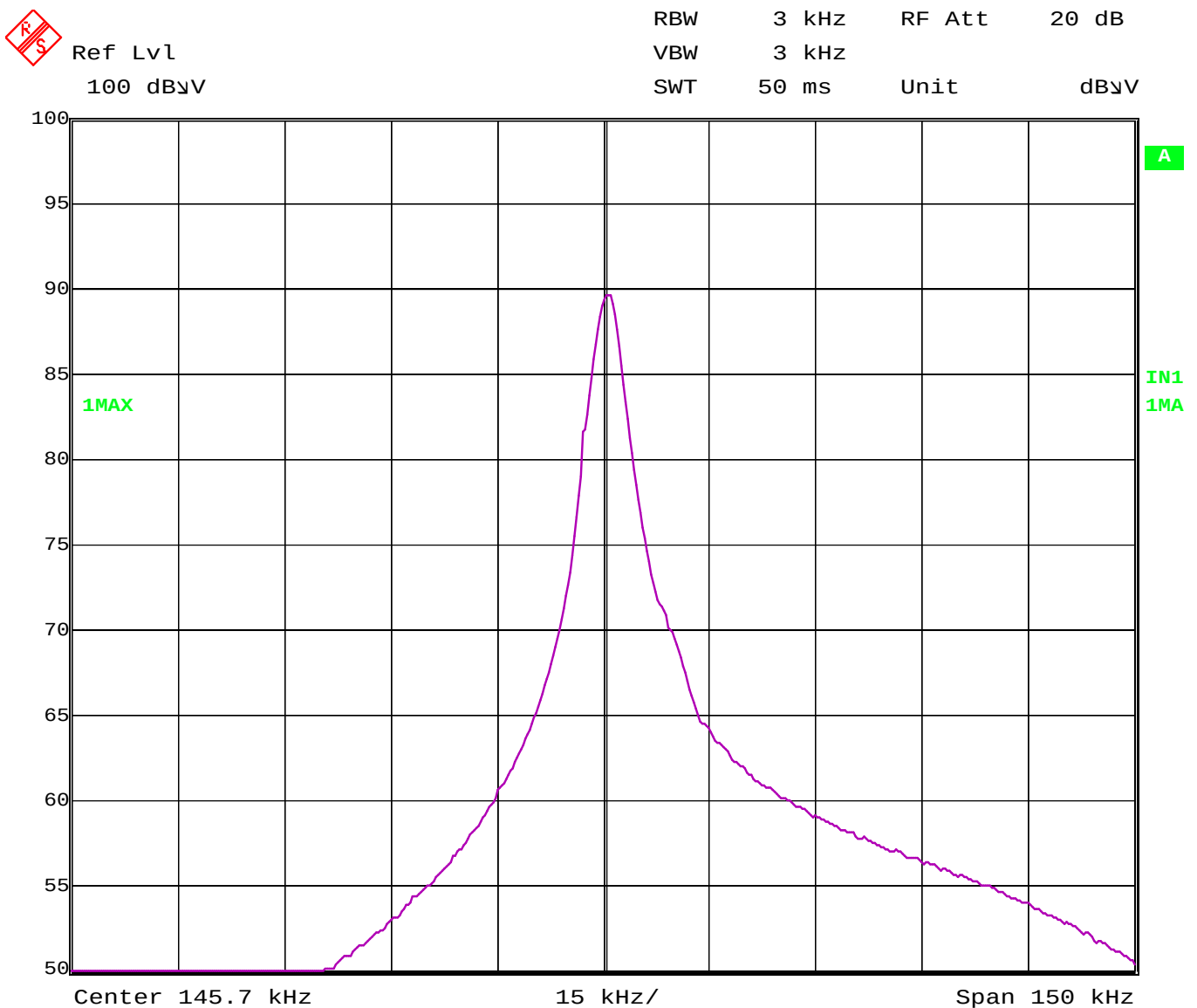
For test instruments and accessories used see section 6 Part MB.

5.5.1 Description of the test location

Test location: AREA4

5.5.2 Test protocol

Emission Bandwidth plot



Date: 18.MAR.2005 10:09:06

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used, in addition to the test accessories, are calibrated and verified regularly.

Test ID	Model Type	Kind of Equipment	Manufacturer	Equipment No.
CPR1	ESCS 30	Test Receiver	Rohde & Schwarz GmbH & Co	04-07/63-99-001
	FMZB 1516	Magnetic Field Antenna	Schwarzbeck Mess-Elektronik	99-07/62-03-004
MB	HZ-10	Magnetic Field Antenna	Rohde & Schwarz GmbH & Co	04-07/62-95-320
	ESIB 40	Test Receiver	Rohde & Schwarz GmbH & Co	04-07/63-03-002
	VLK 04/300	Climatic Chamber	Heraeus -Vötsch GmbH	04-10/90-89-001
SER1	ESCS 30	Test Receiver	Rohde & Schwarz GmbH & Co	04-07/63-99-001
	FMZB 1516	Magnetic Field Antenna	Schwarzbeck Mess-Elektronik	99-07/62-03-004
SER2	Sucofeed 7/8	RF Cable	Huber + Suhner	04-07/60-04-089
	NW-2000-NB	RF Cable	MBPS GmbH	04-07/60-04-205
	EF393-21N-15m	RF Cable	Huber + Suhner	04-07/60-04-258
	VULB 9165	Super Broadband Antenn	Schwarzbeck Mess-Elektronik	04-07/62-00-001
	ESVS 30	Test Receiver	Rohde & Schwarz GmbH & Co	04-07/63-04-001
	Antenna Mast	Antenna Mast	Rohde & Schwarz GmbH & Co	04-07/92-97-002