Registration No. DAT-P-207/05

EMI -- T E S T R E P O R T

- FCC Part 15B -

Test Report No. : **T33552-01-04KJ**	16. September 2010 Date of issue

Type / Model Name : PS1000

Product Description : UWB Ground Penetrating Radar / In-wall imaging Device

Applicant : Hilti Corporation

Address : Feldkircherstrasse 100

FL-9494 Schaan

Manufacturer : Escatec Switzerland AG

Address : Heinrich-Wild-Strasse

CH-9435 Heerbrugg

Licence holder : Hilti Corporation

Address : Feldkircherstrasse 100

FL-9494 Schaan

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Deutscher Akkreditierungs Rat

DAT-P-207/05-00

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15 Subpart A - General (October, 2009)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15 Subpart B - Unintentional Radiators (October, 2009)

Part 15, Subpart B, Section 15.107	AC Line conducted emissions ☐ Class A device ☒ Class B device
Part 15, Subpart B, Section 15.109	Radiated emissions, general requirements
Part 15, Subpart B, Section 15.111	Antenna power conduction
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.
ANSI C95.1:1992	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
CISPR 16-4-2: 2003	Uncertainty in EMC measurement
CISPR 22: 2005 EN 55022: 2006	Information technology equipment

2 SUMMARY

GENERAL REMARKS:

None

FINAL ASSESSMENT:

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

Testing commenced on : 12 July 2010

Testing concluded on : 16 July 2010

Checked by:

Klaus Gegenfurtner
I confirm the correctness and integrity of this document
2010.11.05 10:10:40 +01'00'

Klaus Gegenfurtner
Dipl.-Ing.(FH)
Manager: Radio Group

Tested by:

Josef Knab
I´m the author of this document
2010.11.05 10:09:27 +01'00'

Josef Knab

3 EQUIPMENT UNDER TEST

3.1 Photo documentation of the EUT – Detailed photos see attachment A

3.2 Power supply system utilised

Power supply voltage: : 115 V / 60 Hz / 1ϕ
Battery 7.4 V DC:

3.3 Short description of the Equipment under Test (EUT)

PS 1000 is a field disturbance sensor, designed to examine and map subsurface (or interior wall) structures, which are embedded in (reinforced) concrete. The device is a hand held operated tool, which is designed to operate when in direct contact with the ground (or wall). The device is equipped with a manually operated switch and automatic movement detection provisions that cause the transmitter to cease operation practically instantly when the device is not being operated. The device is equipped with a displayed (LCD) for imaging and evaluation purposes.

Number of tested samples: 2
Serial number: R0 000118V319.05.10 003 (Radiated measurements)
R0 000118V319.05.10 004 (Conducted measurements)

EUT operation mode:

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

- Continuous transmission

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:

-	Monitor (Rugged PC)	Model :	PSA 100
-	Charger (for Monitor)	Model :	PRA 85
-	Battery Pack	Model :	PSA 81
-	USB Mouse	Model :	Microsoft IntelliMouse
-	Interaface Cables	Model :	PSA 50 / PSA 51
-		Model :	

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

mikes-testingpartners 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 may notice that tolerances within the calibration of the equipment and facilities may cause additional uncertainty. The measurement uncertainty is calculated for all measurements listed in this test report acc. to CISPR 16-4-2 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurement“ and documented in the mikes-testingpartners gmbh quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, mikes-testingpartners gmbh, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component diversity and modifications in production processes may result in additional deviation. 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 EUT.

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 set out by the International Special Committee on Radio Interference (CISPR) Publication 22, European Standard EN 55022 as shown under section 1 of this report.

4.4.1.2 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 using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.2 DETAILS OF TEST PROCEDURES

General Standard information

The test methods used comply with CISPR Publication 22, EN 55022 - " Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" and with ANSI C63.4 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". In compliance with 47 CFR Part 15 Subpart A, Section 15.38 testing for FCC compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

4.4.3 Conducted emission

Description of measurement

The final level, expressed in dBµV, 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.

To convert between dBµV and µV, the following conversions apply:

dBµV = 20*log(µV);
µV = 10^(dBµV/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 50Ω/50 µH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin of a peak mode measurement appears to be less than 20 dB, the emissions are remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

4.4.4 Radiated emission (electrical field 30 MHz - 1 GHz)

Description of measurement

Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised 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 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is established in accordance with ANSI C63.4. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so that 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 screened room located outside the test area. The antenna is positioned in horizontal polarisation and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees.
The final level in dBµV/m is calculated by add the correction and cable loss factor (dB) to the reading from the EMI receiver (dBµV). The FCC or CISPR limit is subtracted from this result in order to provide the delta to limit listed in the measurement protocol.

Example:

Frequency	Reading level	+	Factor	=	Level	-	CISPR Limit	=	Delta
(MHz)	(dBµV)		(dB)		(dBµV/m)		(dBµV/m)		(dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

4.4.5 Radiated emission (electrical field 1 GHz - 40 GHz)

Description of measurement

Radiated emission from the EUT are measured in the frequency range 1 GHz up to the maximum frequency as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a 1.0 X 1.5 metre non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is following set out in ANSI C63.4. The 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 screened room located outside the test area. Measurements are made in both the horizontal and vertical polarization planes in a fully anechoic room using a spectrum analyser set to max peak detector function and a resolution 1 MHz and video bandwidth 3 MHz for peak and 10 Hz for average measurement. The conditions determined as worst case will then be used for the final measurements. When the EUT is larger than the beam width of the measuring antenna it will be moved over the surface for the four sides of the equipment. Where appropriate, the test distance may be reduced in order to detect emission under better uncertainty and is calculated to the specified test distance.

5 TEST CONDITIONS AND RESULTS

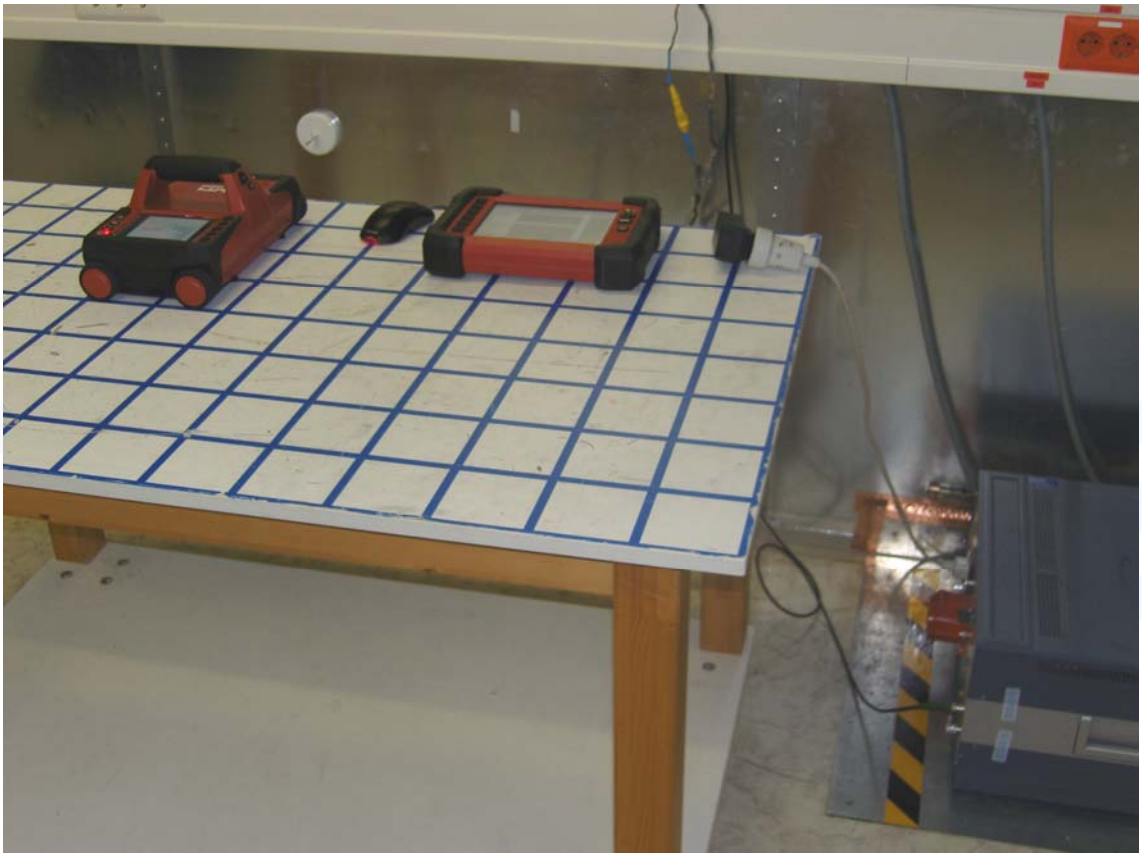
5.1 Conducted emissions

For test instruments and accessories used see section 6 Part **A 4**.

5.1.1 Description of the test location

Test location: Shielded Room S2

5.1.2 Photo documentation of the test set-up



5.1.3 Applicable standard

According to FCC Part 15, Section 15.107(a):
Except for Class A devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the given limits.

5.1.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.4 described under item 4.4.3. If the minimum limit 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.

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin > 10 dB

Limit according to FCC Part 15, Section 15.107(a):

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

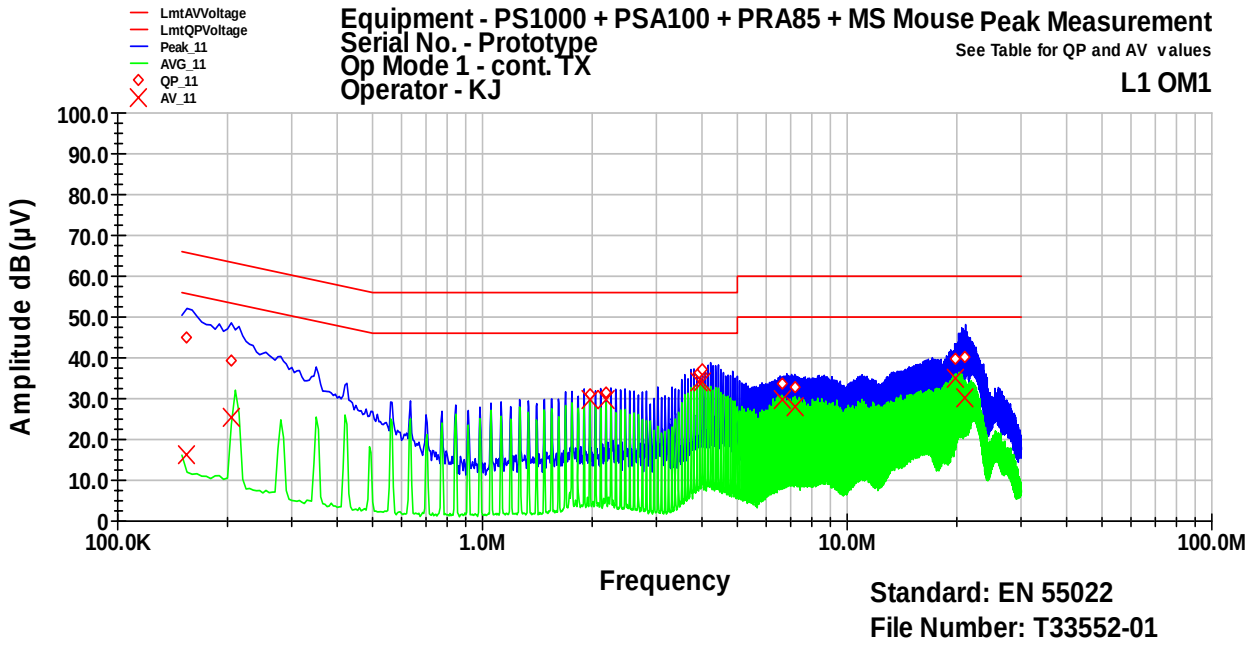
The requirements are **FULFILLED.**

Remarks: For detailed test result please refer to following test protocols

5.1.6 Test protocol

Test point: L1 Result: passed
Operation mode: Continuous transmission
Remarks: PS1000 + PSA100 + PRA85 + Microsoft Mouse
Date: 16. July 2010
Tested by: Klaus Gegenfurtner

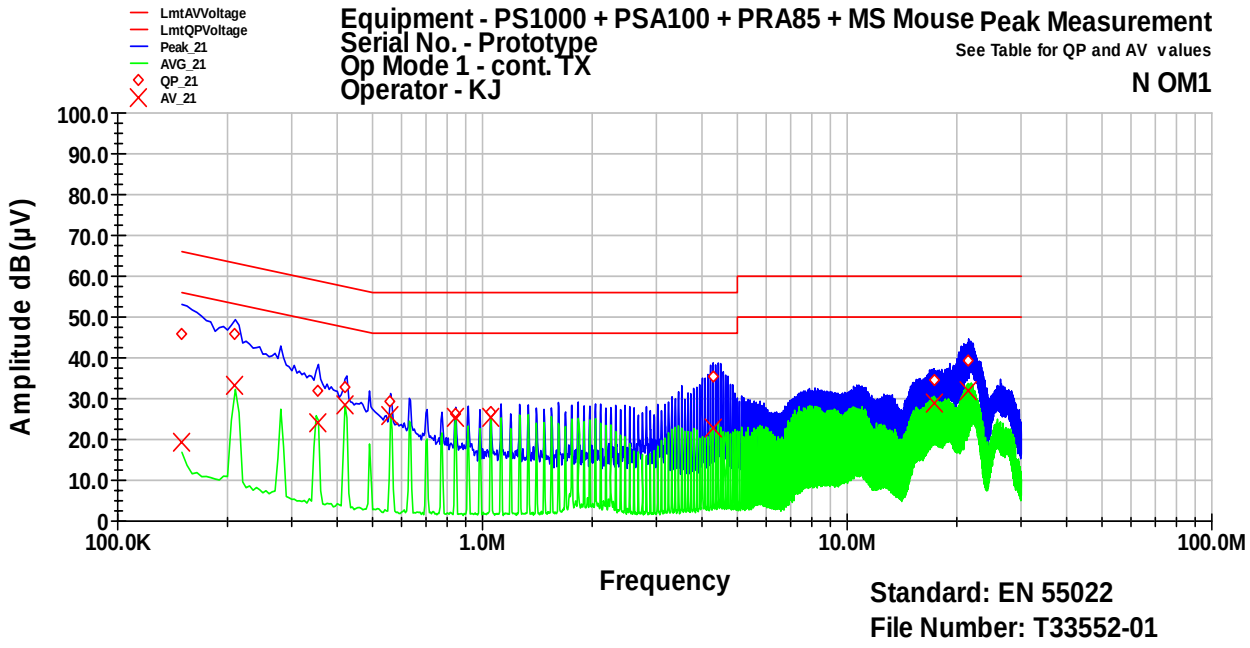
Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.155	45.1	-20.6	65.7	16.1	-39.7	55.7
0.205	39.4	-24.0	63.4	25.4	-28.0	53.4
1.97	31.1	-24.9	56.0	29.6	-16.4	46.0
2.18	31.7	-24.3	56.0	29.7	-16.3	46.0
3.94	36.3	-19.7	56.0	33.9	-12.1	46.0
4.01	37.3	-18.7	56.0	34.3	-11.7	46.0
6.615	33.7	-26.3	60.0	29.8	-20.2	50.0
7.18	33.0	-27.0	60.0	28.1	-21.9	50.0
19.845	39.9	-20.1	60.0	35.0	-15.0	50.0
21.115	40.2	-19.8	60.0	30.4	-19.6	50.0



Test point: N
Operation mode: Continuous transmission
Remarks: PS1000 + PSA100 + PRA85 + Microsoft Mouse
Date: 13. July 2010
Tested by: Klaus Gegenfurtner

Result: passed

Frequency	QP Level	QP Margin	QP Limit	AV Level	AV Margin	AV Limit
MHz	dB(µV)	dB	dB	dB(µV)	dB	dB
0.15	46.0	-20.0	66.0	19.5	-36.5	56.0
0.21	45.8	-17.4	63.2	33.1	-20.1	53.2
0.355	32.0	-26.8	58.8	24.2	-24.6	48.8
0.42	33.0	-24.5	57.4	28.3	-19.1	47.4
0.56	29.2	-26.8	56.0	25.9	-20.1	46.0
0.845	26.4	-29.6	56.0	25.3	-20.7	46.0
1.055	26.8	-29.2	56.0	25.5	-20.5	46.0
4.29	35.4	-20.6	56.0	23.0	-23.0	46.0
17.305	34.4	-25.6	60.0	29.0	-21.0	50.0
21.525	39.5	-20.5	60.0	32.0	-18.0	50.0



5.2 Radiated emissions

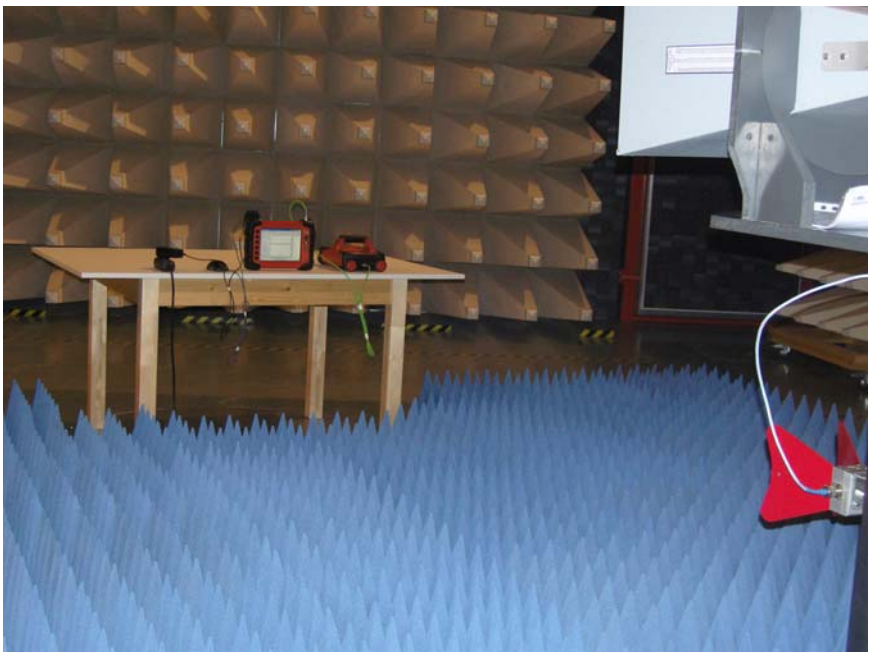
For test instruments and accessories used see section 6 Part **A5**.

5.2.1 Description of the test location

Test location: OATS1
Test distance: 3 metres

Test location: Anechoic Chamber A1
Test distance: 3 metres

5.2.2 Photo documentation of the test setup



Legend for tables:
Level vert. QuasiPeak reading including correction factor for vertically polarised antenna
Level hor. QuasiPeak reading including correction factor for horizontally polarised antenna
Limit Limit referred to the appropriate standard
DLimit… Delta between limit and result (margin)
Noise Characteristic of disturbance (narrowband or broadband)

Instrument settings:
30 MHz – 1000 MHz: RBW: 120 kHz
1000 MHz – 18000 MHz RBW: 1 MHz

5.2.3 Test result

f < 1 GHz

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
30,10	7,9	8,1	12,4	13,2	20,3	21,3	30,0	-8,7
106,06	17,5	15,6	11,1	11,8	28,6	27,4	30,0	-1,4
108,15	14,3	13,1	11,3	12,0	25,6	25,1	30,0	-4,4
108,60	13,8	12,4	11,3	12,0	25,1	24,4	30,0	-4,9
110,16	12,7	10,4	11,5	12,2	24,2	22,6	30,0	-5,8
113,25	9,3	5,3	11,7	12,4	21,0	17,7	30,0	-9,0
133,34	10,8		13,7		24,5		30,0	-5,5
200,00	6,9	6,5	13,2	12,2	20,1	18,7	30,0	-9,9
222,30	6,8		14,0		20,8		30,0	-9,2
250,00	14,6	14,6	14,9	14,4	29,5	29,0	37,0	-7,5
258,03	10,8	10,6	15,2	14,8	26,0	25,4	37,0	-11,0
266,67	10,3	14,8	15,6	15,1	25,9	29,9	37,0	-7,1
307,20	7,5		17,0		24,5		37,0	-12,5
333,33	8,3	7,7	17,6	17,4	25,9	25,1	37,0	-11,1
400,00	4,0	6,9	19,3	19,3	23,3	26,2	37,0	-10,8
500,00	3,2	5,4	21,8	21,9	25,0	27,3	37,0	-9,7
537,61	6,8	13,1	22,8	22,8	29,6	35,9	37,0	-1,1
576,00		4,2		23,7		27,9	37,0	-9,1
960,01	4,6		30,0		34,6		37,0	-2,4

f > 1 GHz

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
1066,0		53,3		-14,2		39,1	50,0	-10,9
1162,0	54,4	54,9	-13,6	-13,6	40,8	41,3	50,0	-8,7
1228,0	53,6		-13,2		40,4		50,0	-9,6
1378,0	58,1	56,2	-13,3	-13,3	44,8	42,9	50,0	-5,2
1420,0	56,9		-13,7		43,2		50,0	-6,8
1456,0	57,8	60,1	-14,2	-14,2	43,6	45,9	50,0	-4,1
1498,0		57,1		-14,7		42,5	50,0	-7,5
1600,0	53,9		-15,0		38,9		50,0	-11,1
1894,0	56,4		-10,5		45,9		50,0	-4,1
5316,0	40,3		4,6		44,9		54,0	-9,1

All frequencies where measured in max. PK mode.

Limit according to EN55022, class B

Frequency (MHz)	Limit (dBµV/m)
30 - 230	30
230 - 1000	37
1000-3000	50 (AV)
3000-6000	54 (AV)

The requirements are **FULFILLED.**

Remarks: The measurement was performed according to EN55022:2006 up to 6000 MHz.

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model / Type	Kind of Equipment	Manufacturer	Equipment No.
A 4	ESHS 30	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-002
	ESH 2 - Z 5	LISN	Rohde & Schwarz München	02-02/20-05-004
	N-4000-BNC	RF Cable	mikes-testingpartners gmbh	02-02/50-05-138
	N-1500-N	RF Cable	mikes-testingpartners gmbh	02-02/50-05-140
	ESH 3 - Z 2	Pulse Limiter	Rohde & Schwarz München	02-02/50-05-155
A 5	ESVS 30	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-006
	FSP 30	Spectrum Analyser	Rohde & Schwarz München	02-02/11-05-001
	AFS4-01000400-10-10P-4	RF Amplifier 1 - 4 GHz	PARZICH GMBH	02-02/17-05-003
	AMF-4F-04001200-15-10P	RF Amplifier 4 - 12 GHz	PARZICH GMBH	02-02/17-05-004
	VULB 9168	Trilog Broadband Antenn	Schwarzbeck Mess-Elektron	02-02/24-05-005
	3117	Horn Antenna 1 - 18 GH	EMCO Elektronik GmbH	02-02/24-05-009
	S10162-B	RF Cable 33 m	Huber + Suhner	02-02/50-05-031
	KK-EF393-21N-16	RF Cable 20 m	Huber + Suhner	02-02/50-05-033
	Sucoflex N-1600-SMA	RF Cable	novotronik Signalverarbeit	02-02/50-05-073
	Sucoflex N-2000-SMA	RF Cable	novotronik Signalverarbeit	02-02/50-05-075
	Sucoflex SMA-1000-SMA	RF Cable	novotronik Signalverarbeit	02-02/50-05-084
	NW-2000-NB	RF Cable	Huber + Suhner	02-02/50-05-113

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Next Verif.
A 4	ESHS 30	02-02/03-05-002	18/06/2011	18/06/2010		
	ESH 2 - Z 5	02-02/20-05-004	13/03/2011	13/03/2008	11/12/2010	11/06/2010
	ESH 3 - Z 2	02-02/50-05-155			07/10/2010	07/04/2010
SER 2	ESVS 30	02-02/03-05-006	11/06/2011	11/06/2010		
	VULB 9168	02-02/24-05-005	06/05/2011	06/05/2008	01/10/2010	01/04/2010
A 5	ESVS 30	02-02/03-05-006	11/06/2011	11/06/2010		
	FSP 30	02-02/11-05-001	04/05/2011	04/05/2010		
	VULB 9168	02-02/24-05-005	06/05/2011	06/05/2008	01/10/2010	01/04/2010
	3117	02-02/24-05-009	10/02/2011	10/02/2010		