Test Report EMC

FCC listed*) test laboratory

Test Laboratory:

VDE Prüf- und Zertifizierungsinstitut
VDE Testing and Certification Institute
Laboratory for EMC measurements

Merianstraße 28
D-63069 Offenbach

Tel.: +49 (0) 69 8306-747
Fax: +49 (0) 69 8306-620
E-mail: Stephan.Kloska@vde.com

Equipment under Test

Applicant:	Braun GmbH, Frankfurter Strasse 145, 61476 Kronberg, Germany
Manufacturer:	Braun GmbH, Baumhofstrasse 40, 97828 Marktheidenfeld, Germany
File number:	263300-2570-0076/82048
EUT:	Intentional radiator: Rechargeable battery-powered tooth brush (Hand piece and tagged brush head), with RF transmitter in the 2400 ... 2483.5 MHz band and RFID reader operating at 13,56 MHz
Brand/model:	BRAUN 3738
EUT received:	2007-02-16

Applied standards

Main Standard	Basic Standards
Standards that have been applied to the radio transmitter:	
47 CFR 15, Subpart C: Intentional Radiators § 15.249 (Operation within the band 2400 - 2483.5 MHz) as an alternative to the general radiated emission as provided in § 15.209	ANSI C63.4:2003
Standards that have been applied to the 13,56 MHz RFID circuitry:	
47 CFR 15, Subpart C: Intentional Radiators §§ 15.201 through 15.209 (General requirements) Alternatives to the general radiated emission limits as provided in §§ 15.217 through 15.255 have not been applied.	ANSI C63.4:2003
Standards that are applicable to the non-radio equipment:	
47 CFR 15, Subpart B: Unintentional Radiators in conjunction with CISPR Pub.22: 1997 Limits for class B equipment	ANSI C63.4:2003

Remarks:	---

Information about modifications to the EUT at the test laboratory:
In order to achieve compliance with the regulations, no modifications were made to the EUT in the course of the tests.

Result:	**Pass**

Date of issue:	2007-04-10	
Tested by:	Mr. Wolfgang Klos EMC Test Engineer	
Reviewed:	Mr. Stephan Kloska, Dr.-Ing. Head of the Laboratory	

*) FCC Information:
A description of the test site pursuant to 47 CFR 2.948 has been filed with the Federal Communications Commission.

Contents Directory

1 Description of the sample (EUT)

1.1 General description

Type of EUT:	The object of this test report is a power tooth brush with radio transmitter operating in the 2400 - 2483.5 MHz band and an RFID tagged brush head operating at 13.56 MHz. It is part of a rechargeable power tooth brush application (Triumph with SmartGuide) with external display unit consisting of • Hand piece (with 2.4 GHz transmitter and 13.56 MHz transceiver) Type 3738 • Display Unit (SmartGuide) with built-in 2,4 GHz receiver Type 3741 • SmartCharger, Type 3731 • Brush head with RFID tag • Stand The battery-powered display unit (3741) and the SmartCharger (3731) with stand are not objects of this test report. These devices are objects of other reports. Hand piece and tagged brush head are considered to be one unit.
Intended use, typical applications:	Electric tooth brush for domestic dental care. It will be used indoors only. The 2.4 GHz radio transmitter utilized in the tooth brush is intended to transmit information on • the operating mode, • the duration of operation, • low battery • pressure on the brush and • Necessity for a change of brush to the SmartGuide display unit with built-in receiver. To identify the brush in use, the brush is equipped with an RFID tag that is being read by a 13.56 MHz transceiver built into the hand piece as well.
Brand name:	BRAUN
Model/Type Designation:	3738
Serial Number:	None

Equipment Type:	Fix or mobile
Signal flow direction:	Operation in the 2400 - 2483,5 MHz band: Simplex Operation at 13,56 MHz: Duplex
Construction of the equipment:	Operation in the 2400 - 2483,5 MHz band Two units: One transmitter in the hand piece (Model 3738) and one receiver in the display unit (Model 3731) Operation at 13,56 MHz: One 13,56 MHz transceiver built in the hand piece and one transponder built in the brush. During normal operation, hand piece and brush can be considered as one unit. *Note: "UNIT" means a physically separate item of the equipment. The equipment under test may consist of two separate units.*

1.2 Technical Specifications

1.2.1 Transmitter

1.2.1.1 Transmitter components

The 2,4 GHz ISM transmitter and the 13,56 MHz transceiver electronics are integrated into the PCB.
A dedicated loop coil antenna is mounted inside the hand piece enclosure.

1.2.1.2 Ports of the transmitter

Power ports:	Battery operated with rechargeable NiMH battery, charged on SmartCharger
Antenna ports:	No external antenna connector
Earth port:	Not applicable
Signal/control ports:	No external ports
Telecommunications ports:	No external ports

1.2.1.3 Transmitter (Transceiver) power supply

Type of power source:	DC/DC converter steps up battery voltage from 0.9 to 1.65V to a stabilized 3 Volt supply voltage for the electronic circuits.
Rated battery voltage:	DC 1.3 V
Automatic transmitter shut-off facility (of the final product):	No. Hand piece transmits in the 2400 MHz to 2483,5 MHz band only when motor is running and for 1 sec after motor has stopped or for 1 sec when toothbrush is put on the charger. Also when a button is pressed or when toothbrush is in setup mode. RFID reader communicates with the brushhead on a 13,56 MHz carrier (reads serial number, brush type, and usage counter value from brushhead). Reads data from brushhead after pressing On/Off button. Energizes the RFID tag every 15 sec for 45 ms when the motor is running and if a brushhead with RFID tag is put on the toothbrush.

Rated power consumption:	Not specified	Rated current:	
Number of phases (if applicable):	N/A	Protection class:	III

1.2.1.4 RF characteristics of the 2.4 GHz ISM transmitter

Operating frequency:	Uses 4 channels (2401 MHz, 2425 MHz, 2427 MHz, 2452 MHz) which are changed sequentially. Sequence repeats after 36 channel changes. Single packet is transmitted on all 4 channels at least one time before information will be updated.
Channel separation (if applicable):	Not applicable
Method of frequency generation:	Integrated PLL system to achieve self adaptive carrier frequency to antenna resonant frequency
Type of modulation:	Binary Frequency Shift Keying (2-FSK) for details refer to the specification of the front end IC
Modulation input signal characteristics:	The modulation signal is generated internally.
Duty cycle of the transmitter:	Duty cycle: in practical use approx. 18% while transmitting at each frequency Total length of one active transmission period: approx. 2 minutes per user, typically not more than 4 users per hour
Intended temperature range:	For normal indoor use (0°C to +55°C)

Maximum rated transmitter output power (as stated by the manufacturer):	< 0,75 mW e.i.r.p.
Variable transmitter carrier output:	No, the output power of the transmitter is fix.

Product variants with alternate power levels:	None

1.2.1.5 RF characteristics of the 13,56 MHz RFID tag reader

Operating frequency:	13,56 MHz
Channel separation (if applicable):	Not applicable
Method of frequency generation:	Integrated PLL system to achieve self adaptive carrier frequency to antenna resonant frequency
Type of modulation:	
Modulation input signal characteristics:	The modulation signal is generated internally, depending on the transponder protocol.
Duty cycle of the transmitter:	< 1% based on number of operations in one hour Intermittent operation
Intended temperature range:	For normal indoor use (0°C to +55°C)

Maximum rated transmitter output power (as stated by the manufacturer):	Below the
Variable transmitter carrier output:	No, the output power of the transmitter is fix.

Product variants with alternate power levels:	None

1.2.1.6 Other constructional details

Oscillators, generated frequencies:	DC/DC converter: approx. 600 kHz Microprocessor clock: 32,768 kHz (crystal oscillator) RFID reader: 13,56 MHz (crystal resonator) ISM Transmitter: 26,00 MHz (crystal oscillator)
Miscellaneous information	Antenna in the handpiece: Induction coil with 12,4 mm diameter, with 10 turns of wire having a diameter of 0,17 mm, integrated into the front of the hand piece Antenna in the brush head: Induction coil with 8,7 mm diameter, with 25-27 turns of wire having a diameter of 0,5 mm, integrated into the shaft of the brush head

Disturbance sources/Components:

No.	Description	Manufacturer	Type designation	Remarks
1	PCB in the hand piece	Braun	D30	Drawing No. 3 738 603
2	DC motor	Mabuchi	FF-180PH-4017	

EMC-measures

No.	Location	Description	Specification	Manufacturer	Type designation
1	PCB	R9	SMD CHIP RESISTOR 220R 5 1/16 0603		
2	PCB	C15	SMD MULTI.CER.CAPACIT.0,15 U M >4 Z5U		

Description of shield- and contacting measures for emc

No.	Description of the measure
1	None

2 Summary of test results

2.1 Transmitter test results

2.1.1 Evaluation against §15.249 (Operation within the 2400-2483.5 MHz band)

Test		Frequency range	Page	Remarks	Result
a)	Electric field strength, fundamental frequency	2400 MHz - 2483,5 MHz	9	---	Pass
a)	Electric field strength, Harmonics	1 GHz - 25 GHz +)	9	---	Pass

+) The upper value of the investigated frequency band was determined according to § 15.33 (b)(1).

2.1.2 Evaluation against §15.209 (Radiated emission limits for intentional radiators, general requirements)

Test		Frequency range	Page	Remarks	Result
a)	Electric field strength	9 kHz - 490 kHz 0,49 MHz - 1,705 MHz 1,705 MHz - 30 MHz	14	---	Pass
		30 MHz - 88 MHz 88 MHz - 216 MHz 216 MHz - 960 MHz 960 MHz - 1 GHz	12	---	Pass
		1 GHz - 25 GHz +)	9	---	Pass

+) The upper value of the investigated frequency band was determined accoding to § 15.33 (b)(1).

2.2 Receiver test results

Not applicable

3 Test and measuring results

3.1 Radiated emissions in the frequency range 1 GHz to 25 GHz

3.1.1 Summary Section

Summarizing table of the highest measurement values relative to the limit, fundamental frequencies

Frequency MHz	Distance m	Antenna Height m	Polarization	EUT Angle 1°	Measured Value dB(µV)	Limit dB(µV/m)	Margin dB	Measured value mV/m	Limit mV/m	Comments
2401	3	1,3	H	270	89,7 Peak	94	4,3	30,6	50	
2425	3	1,3	H	270	91,1 Peak	94	2,9	35,9	50	
2427	3	1,3	H	270	91,1 Peak	94	2,9	35,9	50	
2452	3	1,3	H	270	90,8 Peak	94	3,2	34,5	50	

Summarizing table of the six highest measurement values relative to the limit, Harmonics

Frequency MHz	Distance m	Antenna Height m	Polarization	EUT Angle 1°	Measured Value dB(µV)	Limit dB(µV/m)	Margin dB	Measured value µV/m	Limit µV/m	Comments
4802	3	1,7	V	90	64,0 Peak 49,2 AV	74 Peak 54 AV	10,0 4,8	1585 Peak 288 AV	5000 Peak 500 AV	
7203	3	1,5	V	90	63,8 Peak 49,0 AV	74 Peak 54 AV	10,2 5,0	1556 Peak 283 AV	5000 Peak 500 AV	
7281	3	1,5	V	90	63,0 Peak 48,2 AV	74 Peak 54 AV	11,0 5,8	1414 Peak 257 AV	5000 Peak 500 AV	
7275	3	1,5	H	0	62,3 Peak 47,5 AV	74 Peak 54 AV	11,7 6,5	1302 Peak 237 AV	5000 Peak 500 AV	
4854	3	1,3	H	300	62,0 Peak 47,2 AV	74 Peak 54 AV	12,0 6,8	1263 Peak 230 AV	5000 Peak 500 AV	
4850	3	1,3	H	300	62,0 Peak 47,2 AV	74 Peak 54 AV	12,0 6,8	1255 Peak 228AV	5000 Peak 500 AV	

All readings were taken with the spectrum analyzer manually tuned to the frequency listed in the tables. The resolution bandwidth of the spectrum analyzer was 1 MHz. The arrangement of the EUT and the antenna height were optimized for maximum reading at each individual frequency.

The average values were calculated from the peak measurement values under consideration of the ratio transmitter on-time/(transmitter on-time + transmitter off-time).

Further information can be found on the following pages.

Result: Pass

The radiated emissions of the EUT in the frequency range 1 GHz to 25 GHz were found to be equal or below the specified limits. The minimum margin of a measurement value to the limit was 4,3 dB at a fundamental frequency and 4,8 dB at a harmonic frequency.

3.1.2 Detailed Test protocol

General information about the test:

Tested by:	Klos, Wolfgang
Test date:	2007-03-07

Instruments:	Test location: OATS (Building N)			
Inventory number	Description	Manufacturer	Type	Date of Last Calibration
1800104	Spectrum-Analyzer 20 Hz ... 40 GHz	R&S	FSEK	2006-06-28 (2 years)
1810066	Log.-per. Antenna 1-26.5 GHz	R&S	HL 025	2006-09-15 (3 years)
1810034	Horn Antenna 3.6 GHz … 7.6 GHz	Ailtech	94613-1	2007-03-05 (5 years)
1810035	Horn Antenna 7.3 GHz … 12 GHz	Ailtech	91891-2	2007-03-05 (5 years)
1810036	Horn Antenna 12 GHz … 18 GHz	Ailtech	94614-1	2007-03-05 (5 years)
1810064	Horn Antenna 15 GHz … 40 GHz	Schwarzbeck	BBHA 9170	2007-03-05 (5 years)
1800128	Amplifier 18 GHz … 40 GHz	MITEQ	JS3-18004000-50-8A	2007-03-05
1810056	Amplifier 0.5 GHz … 18 GHz	DBS Microwave	DWT-18212	2007-02-28

Information concerning the test:

Test set-up:	The EUT was operated in the center on top of a non-conductive table of 80 cm height. The table was located in the center of the turntable.
Operating modes used:	Continuous operation
Test procedure:	Before the EUT was brought to the open-area test site, preliminary tests were done in an absorber-lined room. The measurement distance of the preliminary measurements was 3 m. With this arrangement, the noise characteristics of the EUT had been investigated in order to detect the disturbance frequencies without presence of ambient signals. After evaluation of the preliminary data the EUT was brought to the open area Test site for final measurements. On the open-area test site the EUT was configured according to section 1 of this Test report and as shown on the photographs in the appendix. The EUT was put into the operating mode previously found to be the one with highest emissions. Due to the possible presence of ambient signals on the open-area test site, the disturbance spectrum of the EUT was investigated by manually tuning the spectrum analyzer to the disturbance frequencies detected with the preliminary measurements. The procedure according to Annex C of ANSI C63.4:2003 was applied for obtaining the maximum level of emissions.

Result:	**Pass**

Protocol:

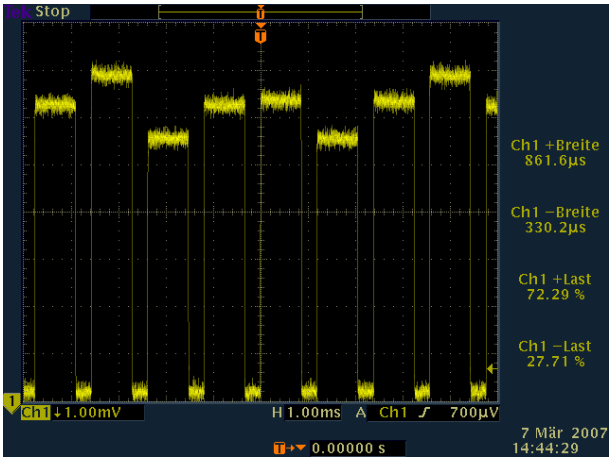
Measurement data sheets can be found in the appendices.

To calculate the average field strength values from the measurement values taken with the peak detector, the following formula was applied for each frequency of interest:

$E_{Average} = E_{Peak}$ * transmitter on-time / duration of an average operating period

The transmitter on-time and off-time were determined with the following method:

A signal picked up from the EUT was fed to the input of an oscilloscope via a matched diode detector.
The running trace was triggered from the video of the measurant.



Transmitter on-time at a certain frequency:
According to the above oscillograph, the transmitter on-time at any frequency is approx. 862 µs.

Average transmitter off-time at a certain frequency:
From the description of the product it is known that the 4 frequencies will be used with equal probability over a period of 36 transmissions. Concerning the duty cycle this means that one average operating cycle consists of one transmission at a certain frequency, three transmissions at other frequencies and four pauses.
So the transmitter off-time within any average period required for four transmissions is approx. 330 µs.

Linear averaging:

$E_{Average}$ = E_{Peak} * transmitter on-time / (transmitter on-time + average transmitter off-time)

= E_{Peak} * 862 µs / (4 * (862 µs + 330 µs))

= E_{Peak} * 0,181

Expressed in logarithmic voltage terms, the average reading is 14,8 dB lower than the peak reading.

3.2 Measurement of the electric field strength (30 MHz – 1000 MHz)

3.2.1 Summary Section

Summarizing table of the six highest measurement values relative to the limit

Frequency MHz	Distance m	Height of Antenna m	Polarization	EUT Angle 1°	Reading dB(µV)	Antenna-factor dB/m	Distance correction dB	Σ dB(µV/m)	Limit dB(µV/m)	Margin dB	Result	Remarks
408,66	10	4	Ver.	270	13,6	18,98	10,46	43,04	46	2,96	PASS	EUT standing
435,9	10	3,6	Ver.	270	13	19,58	10,46	43,04	46	2,96	PASS	EUT standing
435,92	10	2,3	Hor.	0	12,9	19,58	10,46	42,94	46	3,06	PASS	EUT lying on the side
408,7	10	2,9	Hor.	0	13,4	18,98	10,46	42,84	46	3,16	PASS	EUT lying on the side
694,75	10	2,2	Ver.	150	8	23,93	10,46	42,39	46	3,61	PASS	EUT standing
667,5	10	2,2	Ver.	135	6,9	23,67	10,46	41,03	46	4,97	PASS	EUT standing

If not indicated otherwise, all numbers are Quasi-Peak readings (IF-Bandwidth 120 kHz). All readings were taken with the test receiver manually tuned to the frequency listed in the table. The arrangement of the EUT and the antenna height were optimized for maximum reading at each individual frequency.
The measurements were conducted while the EUT was set up as table-top equipment in a typical configurations as described in the detailed protocol on the following pages.

Result: Pass

The measured radiated emissions of the EUT in the frequency range of 30 MHz to 1 GHz were found to be equal or below the specified limits.
The minimum margin of a measurement value to the limit was 2,96 dB.

3.2.2 Detailed Test Protocol

General information about the test:

Tested by:	Klos, Wolfgang
Test date:	2007-03-09

Instruments:		Test location: OATS (Building N)		
Inventory number	Description	Manufacturer	Type	Date of Last Calibration
1150007	EMI Test Receiver 25 MHz ... 1000 MHz	R&S	ESVS30	2006-06-26
1810061	Trilog Antenna	Schwarzbeck	VULB 9163	2007-01-15 (2 years)

Information concerning the test:

Test set-up:	The EUT was operated in the center on top of a non-conductive table of 80 cm height. The table was located in the center of the turntable.
Operating modes:	Continuous operation
Test procedure:	Before the EUT was brought to the open-area test site, preliminary tests were done in an absorber-lined room. The measurement distance of the preliminary measurements was 3 m. With this arrangement, the noise characteristics of the EUT had been investigated in order to detect the disturbance frequencies without presence of ambient signals. After evaluation of the preliminary data the EUT was brought to the open area test site for final measurements. On the open-area test site the EUT was configured according to section 1 and as shown on the photographs in the appendix. The EUT was put into the operating mode previously found to be the one with highest emissions. Due to the possible presence of ambient signals on the open-area test site, the disturbance spectrum of the EUT was investigated by manually tuning the receiver to the disturbance frequencies detected with the preliminary measurements. The procedure according to Annex C of ANSI C63.4:2003 was applied for obtaining the maximum level of emissions.

Result:	**Pass**

Protocol:

The final measurements were made with a test distance of 10 m. Since the limits are specified for 3 m test distance, a correction factor of 10,46 dB (extrapolation with 20 dB/decade) was applied.
Measurement data sheets can be found in the appendices.

3.3 Measurement of radiated emissions (9 kHz – 30 MHz)

3.3.1 Summary Section

Summarizing table of the highest measurement values relative to the limit, fundamental frequency

Frequency MHz	Distance m	Antenna Height m	EUT Angle 1°	Instrument reading dB(µV/m)	Distance correction dB	Measured value dB(µV/m)	Measured value µV/m	Limit µV/m	Comments
13,56	3	1	180	43,5	-40	3,5	1,5	30	

Summarizing table of the highest measurement values relative to the limit, Harmonics and spurious noise

Frequency MHz	Distance m	Antenna Height m	EUT Angle 1°	Instrument reading dB(µV/m)	Distance correction dB	Measured value dB(µV/m)	Measured value µV/m	Limit µV/m	Comments
27,24	1	1	180	26,5	-29,5	-3,0	0,7	30	

If not indicated otherwise, all numbers are Quasi Peak readings (IF Bandwidth 200 Hz respectively 9 kHz for frequencies above 150 kHz). All readings were taken with the receiver manually tuned to the frequency of interest. The arrangement of the EUT and the antenna height were optimized for maximum reading at each individual frequency.
The measurements were conducted while the EUT was set up as table-top equipment in a typical configuration as described in the detailed protocol. Further information can be found on the following pages.

Result: Pass

The measured radiated emissions of the EUT in the frequency range of 9 kHz to 30 MHz were found to be equal or below the specified limits.
The minimum margin of a measurement value to the limit (for average readings) was 26 dB.

3.3.2 Detailed Test Protocol

General information about the test:

Tested by:	Klos, Wolfgang
Test date:	2007-03-06

Instruments:	Test location: OATS (Building N)			
Inventory number	Description	Manufacturer	Type	Date of Last Calibration
1810009	Shielded Loop Antenna	R&S	HFH2-Z2	2006-09-25
1800118	EMI Test Receiver 20 Hz ... 26,5 GHz	R&S	ESI26	2005-06-28 (2 years)

Information concerning the test:

Test set-up:	The EUT was operated in the center on top of a non-conductive table of 80 cm height. The table was located in the center of the turntable.
Operating modes:	Continuous operation
Test procedure:	Before the EUT was brought to the open-area test site, preliminary tests were done in an absorber-lined room. The measurement distance of the preliminary measurements was 1 m. With this arrangement, the noise characteristics of the EUT had been investigated in order to detect the disturbance frequencies without presence of ambient signals. After evaluation of the preliminary data the EUT was brought to the open area Test site for final measurements. On the open-area test site the EUT was configured according to section 1 and as shown on the photographs in the appendix. The EUT was put into the operating mode previously found to be the one with highest emissions. Due to the possible presence of ambient signals on the open-area test site, the disturbance spectrum of the EUT was investigated by manually tuning the receiver to the disturbance frequencies detected with the preliminary measurements.

Result:	**Pass**

Protocol:

The magnetic field strength was measured on an open-area test-site under normal operating conditions at distances of 1 m and 3 m, employing a Quasi Peak detector. For 30 m test distance, a correction factor of 40 dB/decade was used at 13,56 MHz. At 27.24 MHz, a correction factor of 20 dB/decade was applied.

Maximum H-field of the wanted signal at 13.56 MHz, calculated for a distance of 30 m:

Measured value (max. field strength level): - 1,5 µV/m
Specified limit: + 30,0 µV/m

Result concerning the transmitter characteristics (H-Field of the wanted signal): Pass

The level of the wanted signal of the EUT was found below the specified limit.

Maximum H-field of the 2nd harmonic at 27.24 MHz, calculated for a distance of 30 m:

Measured value (max. field strength level): - 0,7 µV/m
Specified limit: + 30,0 µV/m

Result concerning the transmitter characteristics
(H-Field of harmonics and other disturbances): Pass

The level of the wanted signal of the EUT was found below the specified limit.

Results of the final measurements at the open area test site:

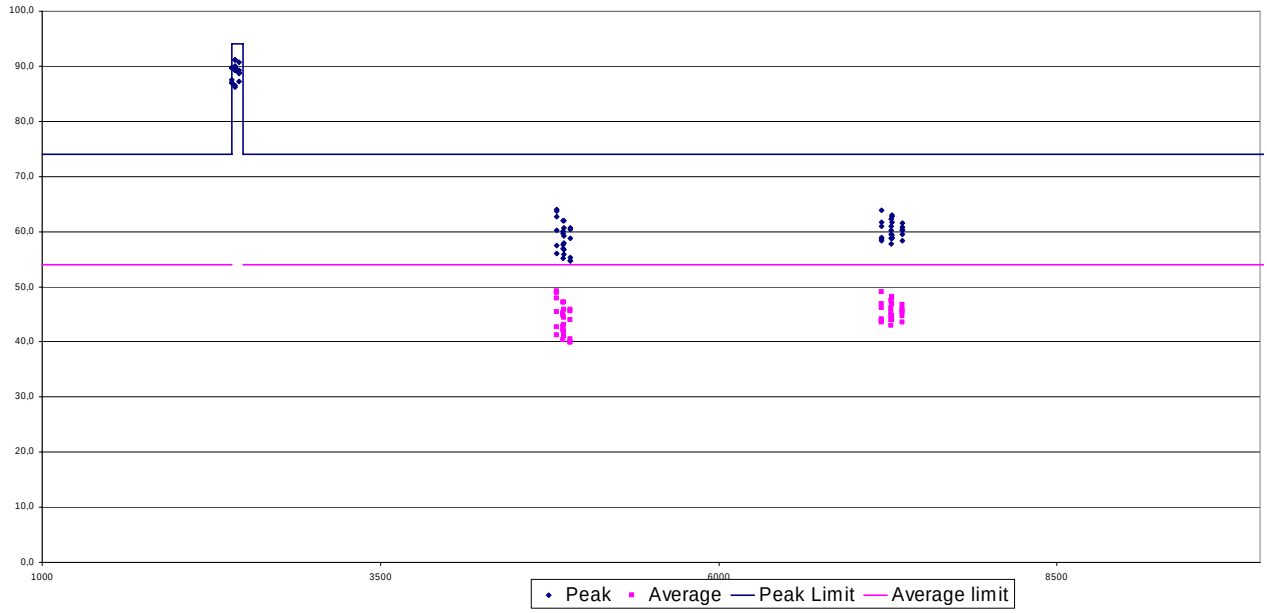
Frequency MHz	Test Distance m	Field Strength dBµV/m	Detector Type	Remarks
13,56	1	+63,5	Quasi Peak	Measured value Receive antenna of the test instrumentation oriented in parallel to the front of the hand piece
	3	+43,5	Quasi Peak	Measured value
	30	-3,5	Quasi Peak	Calculated value from the 3 m reading, using a correction factor of 40 dB per decade
	30	29,5	Quasi Peak	Limit at the specified measurement distance

Frequency MHz	Test Distance m	Field Strength dBµV/m	Detector Type	Remarks
27,26	1	+26,5	Quasi Peak	Measured value (signal level less than 6 dB over the noise floor) Receive antenna of the test instrumentation oriented in parallel to the front of the hand piece
	30	-3,0	Quasi Peak	Calculated value from the 3 m reading, using a correction factor of 20 dB per decade
	30	29,5	Quasi Peak	Limit at the specified measurement distance

Other disturbance frequencies in the frequency ragen from 9 kHz to 30 MHz were not detected at a measurement distance of 3 m.

4 Measurement data

4.1 Test results: Electric field strength, 1 GHz to 25 GHz



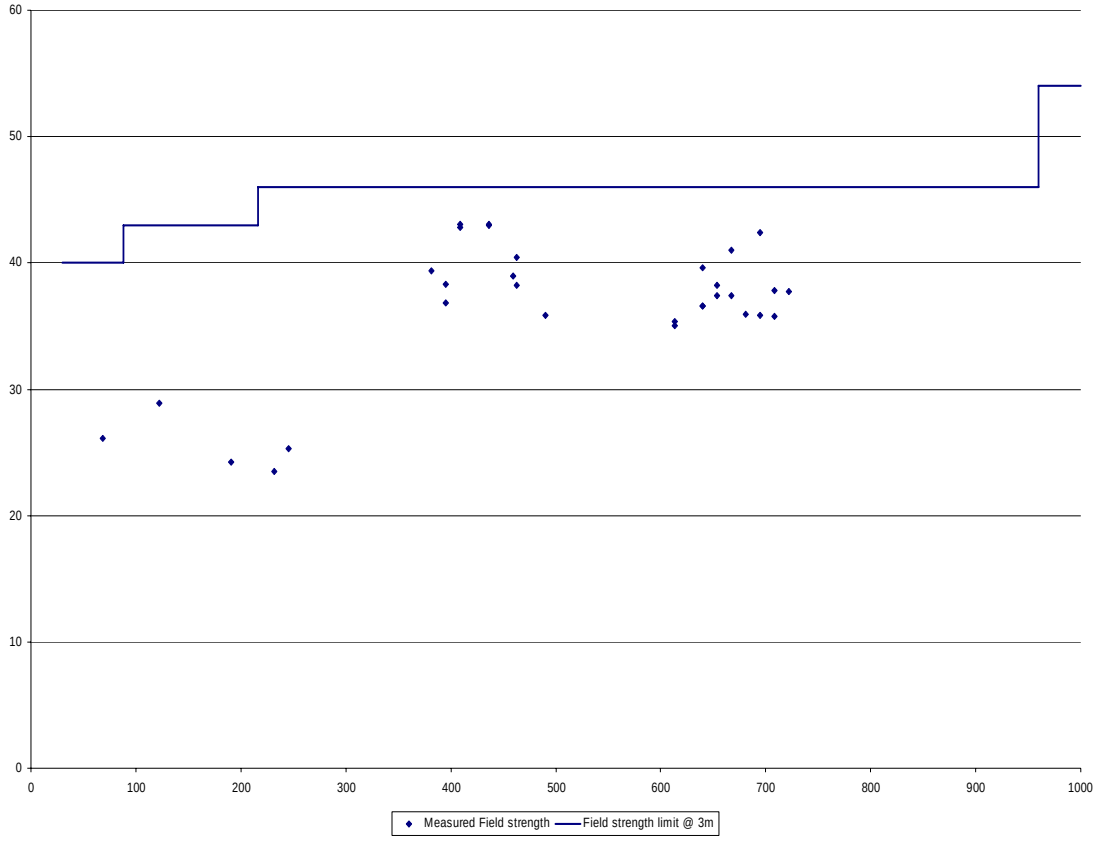
Measurements were made up to 25 GHz.
Above 7,4 GHz, no significant disturbances above the instrumentation noise floor were found.

Frequency	EUT orientation	Azimuth	Antenna height	Polari-zation	Instrument reading	Detector type	Antenna factor	Cable loss	Amplifier gain	Distance correction	Measured value Peak	Measured value Peak	Limit Peak	Margin	Result
MHz	-	°	m	-	dB(µV)	-	dB(1/m)	dB	dB	dB	dB(µV/m)	µV/m	dB(µV/m)	dB	-
2425	lying on the side	270	1,3	H	59,38	Peak	29,34	2,38	0,00	0,00	91,1	35892	94,0	2,9	pass
2427	lying on the side	270	1,3	H	59,38	Peak	29,34	2,38	0,00	0,00	91,1	35892	94,0	2,9	pass
2452	lying on the side	270	1,3	H	58,97	Peak	29,38	2,40	0,00	0,00	90,8	34475	94,0	3,3	pass
2401	lying on the side	270	1,3	H	58,05	Peak	29,30	2,36	0,00	0,00	89,7	30584	94,0	4,3	pass
2452	lying on the back	90	1,3	H	57,53	Peak	29,38	2,40	0,00	0,00	89,3	29208	94,0	4,7	pass
2425	lying on the back	90	1,3	H	57,53	Peak	29,34	2,38	0,00	0,00	89,3	29007	94,0	4,8	pass
2427	lying on the back	90	1,3	H	57,53	Peak	29,34	2,38	0,00	0,00	89,3	29007	94,0	4,8	pass
2401	lying on the back	90	1,3	H	55,83	Peak	29,30	2,36	0,00	0,00	87,5	23686	94,0	6,5	pass
2452	standing upright	180	1,3	H	55,46	Peak	29,38	2,40	0,00	0,00	87,2	23014	94,0	6,8	pass
2401	standing upright	180	1,3	H	55,46	Peak	29,30	2,36	0,00	0,00	87,1	22699	94,0	6,9	pass
2427	standing upright	180	1,3	H	54,81	Peak	29,34	2,38	0,00	0,00	86,5	21208	94,0	7,5	pass
2425	standing upright	180	1,3	H	54,55	Peak	29,34	2,38	0,00	0,00	86,3	20583	94,0	7,7	pass
2425	lying on the side	0	2,2	V	58,31	Peak	29,34	2,38	0,00	0,00	90,0	31732	94,0	4,0	pass
2427	lying on the side	0	2,2	V	58,31	Peak	29,34	2,38	0,00	0,00	90,0	31732	94,0	4,0	pass
2427	standing upright	180	2,2	V	58,18	Peak	29,34	2,38	0,00	0,00	89,9	31261	94,0	4,1	pass
2425	lying on the back	0	2,2	V	58,05	Peak	29,34	2,38	0,00	0,00	89,8	30796	94,0	4,2	pass
2401	lying on the back	0	2,2	V	58,05	Peak	29,30	2,36	0,00	0,00	89,7	30584	94,0	4,3	pass
2401	lying on the side	0	2,2	V	58,05	Peak	29,30	2,36	0,00	0,00	89,7	30584	94,0	4,3	pass
2425	standing upright	180	2,2	V	57,92	Peak	29,34	2,38	0,00	0,00	89,6	30339	94,0	4,4	pass
2427	lying on the back	0	2,2	V	57,79	Peak	29,34	2,38	0,00	0,00	89,5	29888	94,0	4,5	pass
2452	lying on the back	0	2,2	V	57,01	Peak	29,38	2,40	0,00	0,00	88,8	27511	94,0	5,2	pass
2452	lying on the side	0	2,2	V	57,01	Peak	29,38	2,40	0,00	0,00	88,8	27511	94,0	5,2	pass
2452	standing upright	180	2,2	V	56,89	Peak	29,38	2,40	0,00	0,00	88,7	27133	94,0	5,3	pass
2401	standing upright	180	2,2	V	55,21	Peak	29,30	2,36	0,00	0,00	86,9	22055	94,0	7,1	pass

Frequency	EUT orientation	Azimuth	Antenna height	Polari-zation	Instrument reading	Detector type	Antenna factor	Cable loss	Amplifier gain	Distance correction	Measured value Peak	Measured value Peak	Limit Peak	Margin	Result		Correction Average	Calculated value Average	Calculated value Average
MHz	-	°	m	-	dB(µV)	-	dB(1/m)	dB	dB	dB	dB(µV/m)	µV/m	dB(µV/m)	dB	-		dB	dBµV/m	µV/m
4802	lying on the side	90	1,7	V	55,27	Peak	36,81	0,00	28,08	0,00	64,0	1585	74,0	10,0	pass		-14,8	49,2	288
7203	lying on the side	90	1,5	V	54,15	Peak	36,73	0,00	27,04	0,00	63,8	1556	74,0	10,2	pass		-14,8	49,0	283
4802	standing upright	300	1,3	H	54,96	Peak	36,81	0,00	28,08	0,00	63,7	1529	74,0	10,3	pass		-14,8	48,9	278
7281	lying on the side	90	1,5	V	53,25	Peak	36,81	0,00	27,05	0,00	63,0	1414	74,0	11,0	pass		-14,8	48,2	257
4802	lying on the back	60	1,7	V	54,01	Peak	36,81	0,00	28,08	0,00	62,7	1371	74,0	11,3	pass		-14,8	47,9	250
7281	lying on the back	180	1,5	V	52,95	Peak	36,81	0,00	27,05	0,00	62,7	1366	74,0	11,3	pass		-14,8	47,9	249
7275	standing upright	0	1,5	H	52,54	Peak	36,81	0,00	27,06	0,00	62,3	1302	74,0	11,7	pass		-14,8	47,5	237
4854	standing upright	300	1,3	H	53,40	Peak	36,83	0,00	28,20	0,00	62,0	1263	74,0	12,0	pass		-14,8	47,2	230
4850	standing upright	300	1,3	H	53,35	Peak	36,83	0,00	28,21	0,00	62,0	1255	74,0	12,0	pass		-14,8	47,2	228
7203	standing upright	0	1,5	H	52,01	Peak	36,73	0,00	27,04	0,00	61,7	1216	74,0	12,3	pass		-14,8	46,9	221
7281	standing upright	0	1,5	H	51,87	Peak	36,81	0,00	27,05	0,00	61,6	1206	74,0	12,4	pass		-14,8	46,8	220
7356	lying on the side	90	1,5	V	51,73	Peak	36,82	0,00	27,08	0,00	61,5	1184	74,0	12,5	pass		-14,8	46,7	216
7203	lying on the back	180	1,5	V	51,33	Peak	36,73	0,00	27,04	0,00	61,0	1125	74,0	13,0	pass		-14,8	46,2	205
7275	lying on the back	180	1,5	V	51,19	Peak	36,81	0,00	27,06	0,00	60,9	1114	74,0	13,1	pass		-14,8	46,1	203
7356	standing upright	0	1,5	H	51,05	Peak	36,82	0,00	27,08	0,00	60,8	1095	74,0	13,2	pass		-14,8	46,0	199
4904	lying on the back	60	1,7	V	51,87	Peak	36,95	0,00	28,13	0,00	60,7	1083	74,0	13,3	pass		-14,8	45,9	197
4854	lying on the back	60	1,7	V	52,01	Peak	36,83	0,00	28,20	0,00	60,6	1076	74,0	13,4	pass		-14,8	45,8	196
7356	lying on the back	180	1,5	V	50,64	Peak	36,82	0,00	27,08	0,00	60,4	1045	74,0	13,6	pass		-14,8	45,6	190
4904	standing upright	300	1,3	H	51,50	Peak	36,95	0,00	28,13	0,00	60,3	1038	74,0	13,7	pass		-14,8	45,5	189
7275	lying on the side	90	1,5	V	50,50	Peak	36,81	0,00	27,06	0,00	60,3	1029	74,0	13,8	pass		-14,8	45,5	187
7356	lying on the side	0	1,3	H	50,50	Peak	36,82	0,00	27,08	0,00	60,2	1028	74,0	13,8	pass		-14,8	45,4	187
4802	lying on the side	0	2	H	51,46	Peak	36,81	0,00	28,08	0,00	60,2	1022	74,0	13,8	pass		-14,8	45,4	186
4850	lying on the back	60	1,7	V	51,46	Peak	36,83	0,00	28,21	0,00	60,1	1009	74,0	13,9	pass		-14,8	45,3	184
4850	lying on the side	90	1,7	V	51,05	Peak	36,83	0,00	28,21	0,00	59,7	963	74,0	14,3	pass		-14,8	44,9	175
7275	standing upright	210	1,7	V	49,81	Peak	36,81	0,00	27,06	0,00	59,6	951	74,0	14,4	pass		-14,8	44,8	173
7356	standing upright	210	1,7	V	49,81	Peak	36,82	0,00	27,08	0,00	59,6	950	74,0	14,5	pass		-14,8	44,8	173
7281	lying on the side	0	1,3	H	49,67	Peak	36,81	0,00	27,05	0,00	59,4	936	74,0	14,6	pass		-14,8	44,6	170
4854	lying on the side	0	2	H	50,64	Peak	36,83	0,00	28,20	0,00	59,3	919	74,0	14,7	pass		-14,8	44,5	167
7203	lying on the side	0	1,3	H	49,27	Peak	36,73	0,00	27,04	0,00	59,0	887	74,0	15,0	pass		-14,8	44,2	161
7281	lying on the back	90	1,3	H	49,14	Peak	36,81	0,00	27,05	0,00	58,9	881	74,0	15,1	pass		-14,8	44,1	160
4904	lying on the side	0	2	H	49,94	Peak	36,95	0,00	28,13	0,00	58,8	867	74,0	15,2	pass		-14,8	44,0	158
7281	standing upright	210	1,7	V	49,00	Peak	36,81	0,00	27,05	0,00	58,8	867	74,0	15,2	pass		-14,8	44,0	158
7275	lying on the back	90	1,3	H	49,00	Peak	36,81	0,00	27,06	0,00	58,8	866	74,0	15,3	pass		-14,8	44,0	158
7203	lying on the back	90	1,3	H	49,00	Peak	36,73	0,00	27,04	0,00	58,7	860	74,0	15,3	pass		-14,8	43,9	157
7356	lying on the back	90	1,3	H	48,60	Peak	36,82	0,00	27,08	0,00	58,3	826	74,0	15,7	pass		-14,8	43,5	150
7203	standing upright	210	1,7	V	48,60	Peak	36,73	0,00	27,04	0,00	58,3	821	74,0	15,7	pass		-14,8	43,5	149
4854	lying on the side	90	1,7	V	49,27	Peak	36,83	0,00	28,20	0,00	57,9	785	74,0	16,1	pass		-14,8	43,1	143
7275	lying on the side	0	1,3	H	48,06	Peak	36,81	0,00	27,06	0,00	57,8	777	74,0	16,2	pass		-14,8	43,0	141
4850	lying on the side	0	2	H	49,00	Peak	36,83	0,00	28,21	0,00	57,6	760	74,0	16,4	pass		-14,8	42,8	138
4802	standing upright	300	1,7	V	48,73	Peak	36,81	0,00	28,08	0,00	57,5	746	74,0	16,5	pass		-14,8	42,7	136
4850	standing upright	300	1,7	V	48,33	Peak	36,83	0,00	28,21	0,00	57,0	704	74,0	17,1	pass		-14,8	42,2	128
4854	standing upright	300	1,7	V	48,06	Peak	36,83	0,00	28,20	0,00	56,7	683	74,0	17,3	pass		-14,8	41,9	124
4802	lying on the back	90	2	H	47,26	Peak	36,81	0,00	28,08	0,00	56,0	630	74,0	18,0	pass		-14,8	41,2	115
4854	lying on the back	90	2	H	47,26	Peak	36,83	0,00	28,20	0,00	55,9	623	74,0	18,1	pass		-14,8	41,1	113
4904	standing upright	300	1,7	V	46,43	Peak	36,95	0,00	28,13	0,00	55,3	579	74,0	18,8	pass		-14,8	40,5	105
4850	lying on the back	90	2	H	46,54	Peak	36,83	0,00	28,21	0,00	55,2	573	74,0	18,8	pass		-14,8	40,4	104
4904	lying on the side	90	1,7	V	45,88	Peak	36,95	0,00	28,13	0,00	54,7	543	74,0	19,3	pass		-14,8	39,9	99
4904	lying on the back	90	2	H	45,88	Peak	36,95	0,00	28,13	0,00	54,7	543	74,0	19,3	pass		-14,8	39,9	99

4.2 Test results: Electric field strength

4.2.1 Frequency range 30 MHz ... 1000 MHz



Test results: Electrical Fieldstrength

Electrical Fieldstrength: Table of measured data

Quasi-peak

Frequency MHz	Distance m	Height of Antenna m	Polarization	EUT Angle 1°	Reading dB(µV)	Antenna-factor dB/m	Distance correction dB	Σ dB(µV/m)	Limit dB(µV/m)	Margin dB	Result	Remarks
68,1	10	1,6	Ver.	0	4,7	10,99	10,46	26,15	40	13,85	PASS	EUT standing
122,6	10	1,2	Ver.	0	7,4	11	10,46	28,86	43	14,14	PASS	EUT standing
190,7	10	1	Ver.	120	1	12,73	10,46	24,19	43	18,81	PASS	EUT standing
231,58	10	1	Ver.	120	-1,2	14,21	10,46	23,47	46	22,53	PASS	EUT standing
245,2	10	1	Ver.	120	0,3	14,55	10,46	25,31	46	20,69	PASS	EUT standing
381,4	10	3,1	Hor.	0	10,8	18,11	10,46	39,37	46	6,63	PASS	EUT lying on the side
395,04	10	4	Ver.	270	7,8	18,55	10,46	36,81	46	9,19	PASS	EUT standing
395,05	10	3,1	Hor.	0	9,3	18,55	10,46	38,31	46	7,69	PASS	EUT lying on the side
408,66	10	4	Ver.	270	13,6	18,98	10,46	43,04	46	2,96	PASS	EUT standing

Fre-quency MHz	Dis-tance m	Height of An-tenna m	Polari-zation	EUT Angle 1°	Reading dB(µV)	Antenna-factor dB/m	Distance correction dB	Σ dB(µV/m)	Limit dB(µV/m)	Mar-gin dB	Result	Remarks
408,7	10	2,9	Hor.	0	13,4	18,98	10,46	42,84	46	3,16	PASS	EUT lying on the side
435,9	10	3,6	Ver.	270	13	19,58	10,46	43,04	46	2,96	PASS	EUT standing
435,92	10	2,3	Hor.	0	12,9	19,58	10,46	42,94	46	3,06	PASS	EUT lying on the side
459,53	10	3,5	Ver.	270	9	19,52	10,46	38,98	46	7,02	PASS	EUT standing
463,15	10	3,3	Ver.	180	8,1	19,65	10,46	38,21	46	7,79	PASS	EUT standing
463,17	10	2,2	Hor.	0	10,3	19,65	10,46	40,41	46	5,59	PASS	EUT lying on the side
490,4	10	2,1	Hor.	0	4,8	20,58	10,46	35,84	46	10,16	PASS	EUT lying on the side
613,02	10	2,4	Ver.	180	1,5	23,11	10,46	35,07	46	10,93	PASS	EUT standing
613,02	10	1,4	Hor.	0	1,8	23,11	10,46	35,37	46	10,63	PASS	EUT lying on the side
640,25	10	2,4	Ver.	150	2,7	23,45	10,46	36,61	46	9,39	PASS	EUT standing
640,27	10	1,2	Hor.	0	2,7	23,45	10,46	36,61	46	9,39	PASS	EUT lying on the side
640,27	10	1,3	Hor.	180	5,7	23,45	10,46	39,61	46	6,39	PASS	EUT lying on the side
653,88	10	2,3	Ver.	135	4,2	23,58	10,46	38,24	46	7,76	PASS	EUT standing
653,89	10	1,3	Hor.	0	3,4	23,58	10,46	37,44	46	8,56	PASS	EUT lying on the side
667,5	10	2,2	Ver.	135	6,9	23,67	10,46	41,03	46	4,97	PASS	EUT standing
667,51	10	1,4	Hor.	0	3,3	23,67	10,46	37,43	46	8,57	PASS	EUT lying on the side
681,13	10	1,7	Hor.	0	1,7	23,79	10,46	35,95	46	10,05	PASS	EUT lying on the side
694,75	10	2,2	Ver.	150	8	23,93	10,46	42,39	46	3,61	PASS	EUT standing
694,76	10	1,7	Hor.	0	1,5	23,93	10,46	35,89	46	10,11	PASS	EUT lying on the side
708,36	10	1,8	Ver.	140	3,1	24,24	10,46	37,8	46	8,2	PASS	EUT standing
708,38	10	1,3	Hor.	0	1,1	24,24	10,46	35,8	46	10,2	PASS	EUT lying on the side
722	10	1,7	Ver.	135	2,6	24,65	10,46	37,71	46	8,29	PASS	EUT standing

5 Photographs

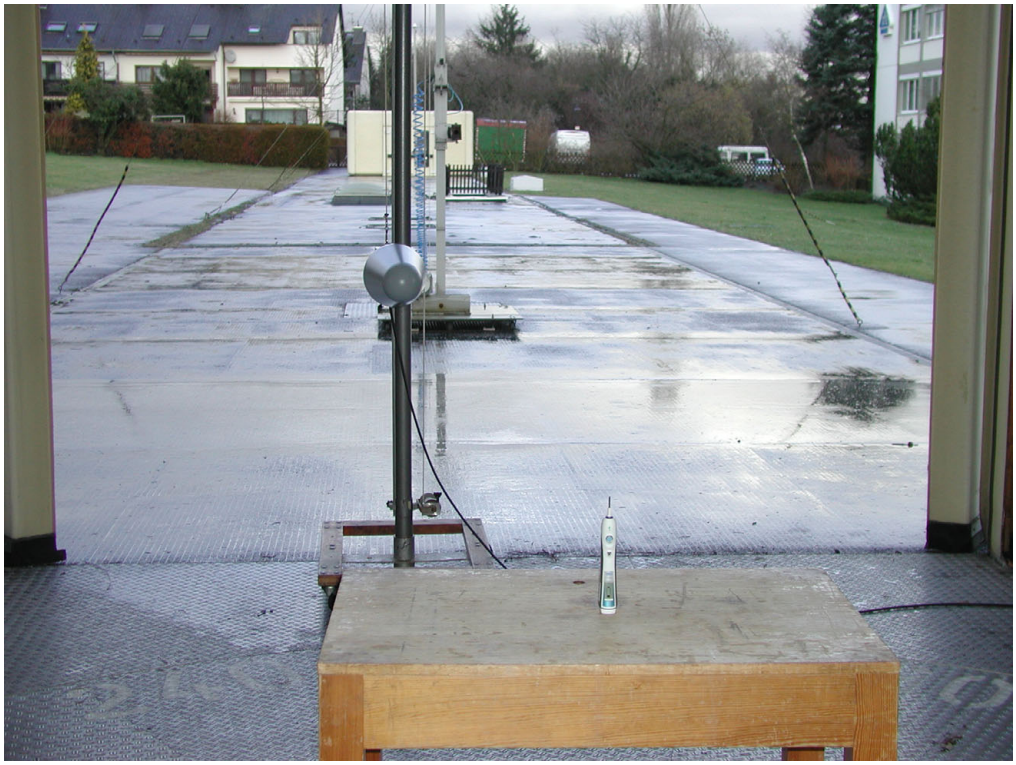


Figure 1

Figure 2

(intentionally left blank)