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
Manufacturer:	Braun GmbH, Baumhofstrasse 40, 97828 Marktheidenfeld, Germany
File number:	263300-2570-0076/92379
EUT:	Tooth-brush, battery-powered with charger
Brand/model:	BRAUN 3738
EUT received:	2007-08-02

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:	Except for the 13,56 MHz tag reader circuitry, the object of this report is similar to the object of Test Report FG43-2-82048.

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:	2007-08-07	
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) 3
1.1 General description 3
1.2 Technical Specifications 4
1.2.1 Transmitter 4
2 Summary of test results 8
2.1 Transmitter test results 8
2.1.1 Evaluation against §15.249 (Operation within the 2400-2483.5 MHz band) 8
2.1.2 Evaluation against §15.209 (Radiated emission limits for intentional radiators, general requirements) 8
2.2 Receiver test results 8
3 Test and measuring results 9
3.1 Radiated emissions in the frequency range 1 GHz to 25 GHz 9
3.1.1 Summary Section 9
3.1.2 Detailed Test protocol 10
3.2 Measurement of the electric field strength (30 MHz – 1000 MHz) 12
3.2.1 Summary Section 12
3.2.2 Detailed Test Protocol 13
3.3 Measurement of radiated emissions (9 kHz – 30 MHz) 14
3.3.1 Summary Section 14
3.3.2 Detailed Test Protocol 15
4 Measurement data 17
4.1 Test results: Electric field strength, 1 GHz to 25 GHz 17
4.2 Test results: Electric field strength 21
4.2.1 Frequency range 30 MHz ... 1000 MHz 21
5 Photographs 24

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:	Prototype, with the following modification: To reduce the time for testing, the EUT was submitted with a modified software enabling transmissions of the 13,56 MHz reader every 2 seconds instead of 15 seconds. No other modifications were made.

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:	Energizing transmitter: None Tag: AM
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 radiated emission limits specified in 47 CFR 15.209 (a)
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. 1200 kHz Microprocessor clock: 32,768 kHz (crystal oscillator) RFID reader: 13,56 MHz (crystal oscillator) 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. 63 738 602
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	1,2	V	0	91,1 Peak 76,3 AV	114 Peak 94 AV	22,9 17,7	36,0 Peak 6,55 AV	500 Peak 50 AV	
2425	3	1,2	V	0	91,0 Peak 76,2 AV	114 Peak 94 AV	23,0 17,8	35,6 Peak 6,48 AV	500 Peak 50 AV	
2427	3	1,2	V	0	91,0 Peak 76,2 AV	114 Peak 94 AV	23,0 17,8	35,4 Peak 6,44 AV	500 Peak 50 AV	
2452	3	1,2	V	0	90,4 Peak 75,6 AV	114 Peak 94 AV	23,6 18,4	33,1 Peak 6,0 AV	500 Peak 50 AV	

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
4850	3	1,7	V	300	57,9 Peak 43,1 AV	74 Peak 54 AV	16,1 10,8	782 142	5000 Peak 500 AV	
4802	3	1,7	V	300	57,6 Peak 42,8 AV	74 Peak 54 AV	16,4 11,2	759 138	5000 Peak 500 AV	
7203	3	1,7	V	210	57,4 Peak 42,6 AV	74 Peak 54 AV	16,7 11,4	737 134	5000 Peak 500 AV	
4854	3	1,7	V	300	57,0 Peak 42,2 AV	74 Peak 54 AV	17,0 11,8	706 128	5000 Peak 500 AV	
4904	3	1,7	V	60	56,2 Peak 41,4 AV	74 Peak 54 AV	17,8 12,6	643 117	5000 Peak 500 AV	
4850	3	1,7	V	60	56,2 Peak 41,4 AV	74 Peak 54 AV	17,8 12,6	643 117	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 17,7 dB at a fundamental frequency and 10,8 dB at a harmonic frequency.

3.1.2 Detailed Test protocol

General information about the test:

Tested by:	Klos, Wolfgang
Test date:	2007-08-02

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:

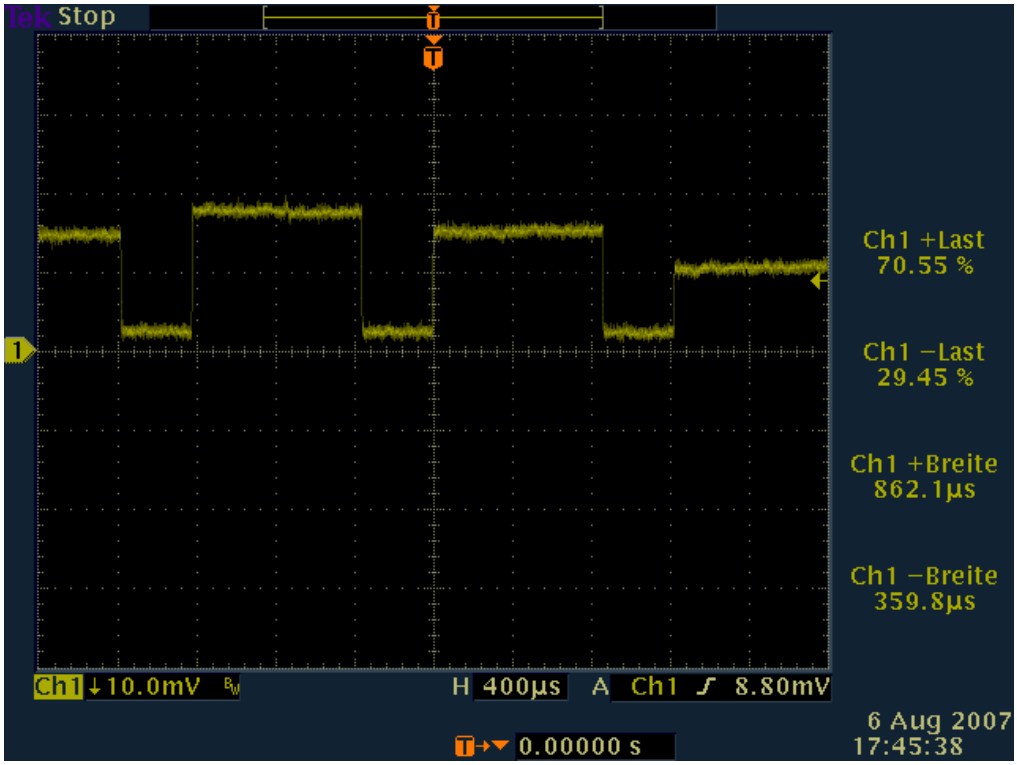
Measurement data sheets can be found in the appendices.

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
461,09	10	2,4	Hor.	0	13,5	19,57	10,46	43,53	46	2,47	PASS	lying on the side
637,39	10	1,4	Hor.	150	9,4	23,42	10,46	43,28	46	2,72	PASS	lying on the back
664,51	10	1,6	Hor.	150	8	23,65	10,46	42,11	46	3,89	PASS	lying on the side
488,21	10	1,9	Hor.	0	11	20,53	10,46	41,99	46	4,01	PASS	lying on the side
610,27	10	1,9	Hor.	150	8	23,07	10,46	41,53	46	4,47	PASS	lying on the side
474,65	10	2,3	Hor.	0	9,9	20,13	10,46	40,49	46	5,51	PASS	lying on the side

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 2,47 dB.

3.2.2 Detailed Test Protocol

General information about the test:

Tested by:	Klos, Wolfgang
Test date:	2007-08-02

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

Fre-quency	Distance	Antenna Height	EUT Angle	Instrument reading	Distance correction	Measured value	Measured value	Limit	Comments
MHz	m	m	1°	dB(µV/m)	dB	dB(µV/m)	µV/m	µV/m	
13,56	3	1	180	33	-40	-7	0,45	30	

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

Fre-quency	Distance	Antenna Height	EUT Angle	Instrument reading	Distance correction	Measured value	Measured value	Limit	Comments
MHz	m	m	1°	dB(µV/m)	dB	dB(µV/m)	µV/m	µV/m	
27,12	1	1	180	< 20	-29,5	< -9,5	< 0,33	30	No signal found. The values in the table indicate the noise level.

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 was 36,5 dB.

3.3.2 Detailed Test Protocol

General information about the test:

Tested by:	Klos, Wolfgang
Test date:	2007-08-02

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 27.12 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): 0,45 µV/m
Specified limit: 30,00 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 27.12 MHz, calculated for a distance of 30 m:

Measured value (max. field strength level): < 0,33 µV/m
Specified limit: 30,00 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:

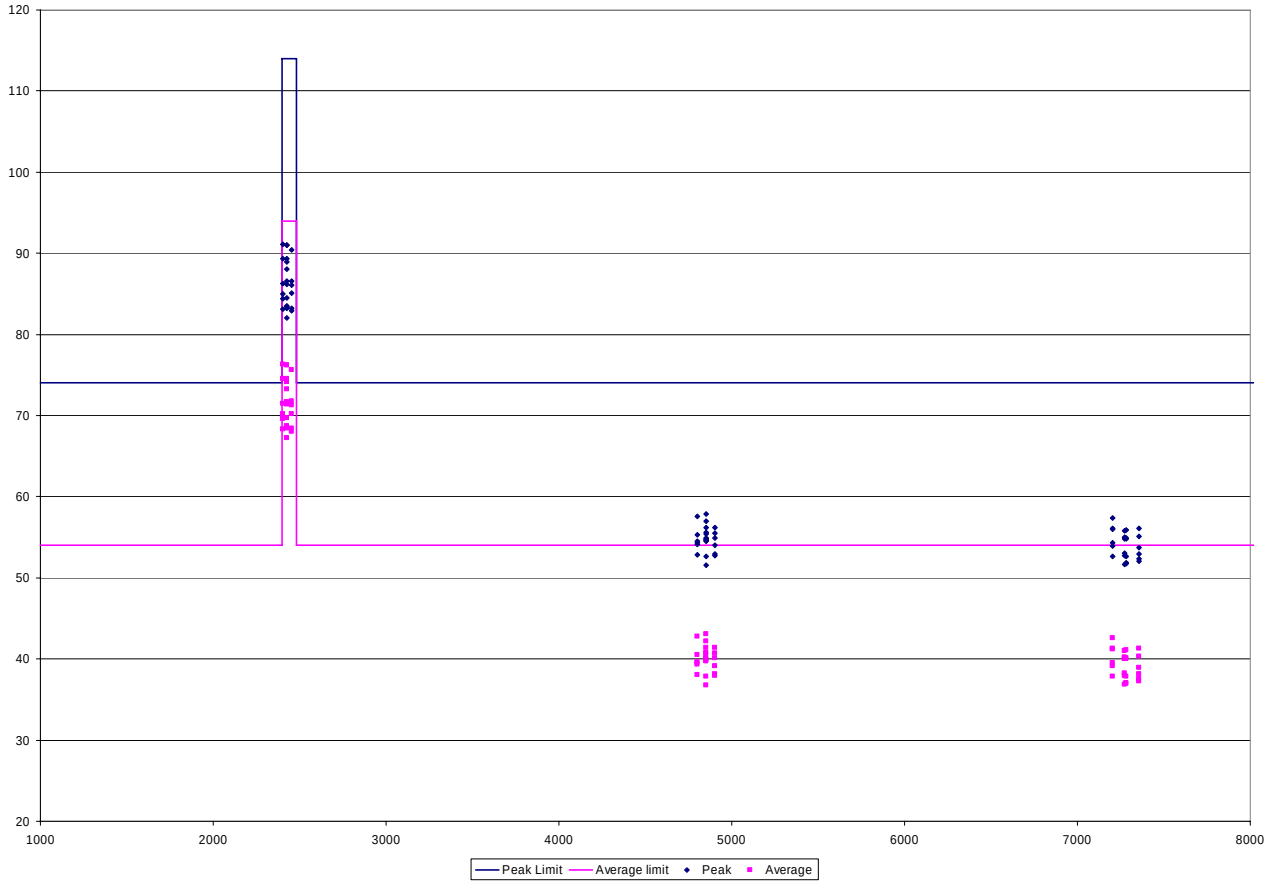
Frequency MHz	Test Distance m	Field Strength dBµV/m	Detector Type	Remarks
13,56	1	+63,0	Quasi Peak	Measured value Receive antenna of the test instrumentation oriented in parallel to the front of the hand piece
	3	+33,0	Quasi Peak	Measured value
	30	- 7,0	Quasi Peak	Calculated value from the 3 m reading, 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
27,12	1	< 20	Quasi Peak	Measured value (signal below the noise floor)
	3	< 20	Quasi Peak	Measured value (signal below the noise floor)
	30	< 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 range 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.

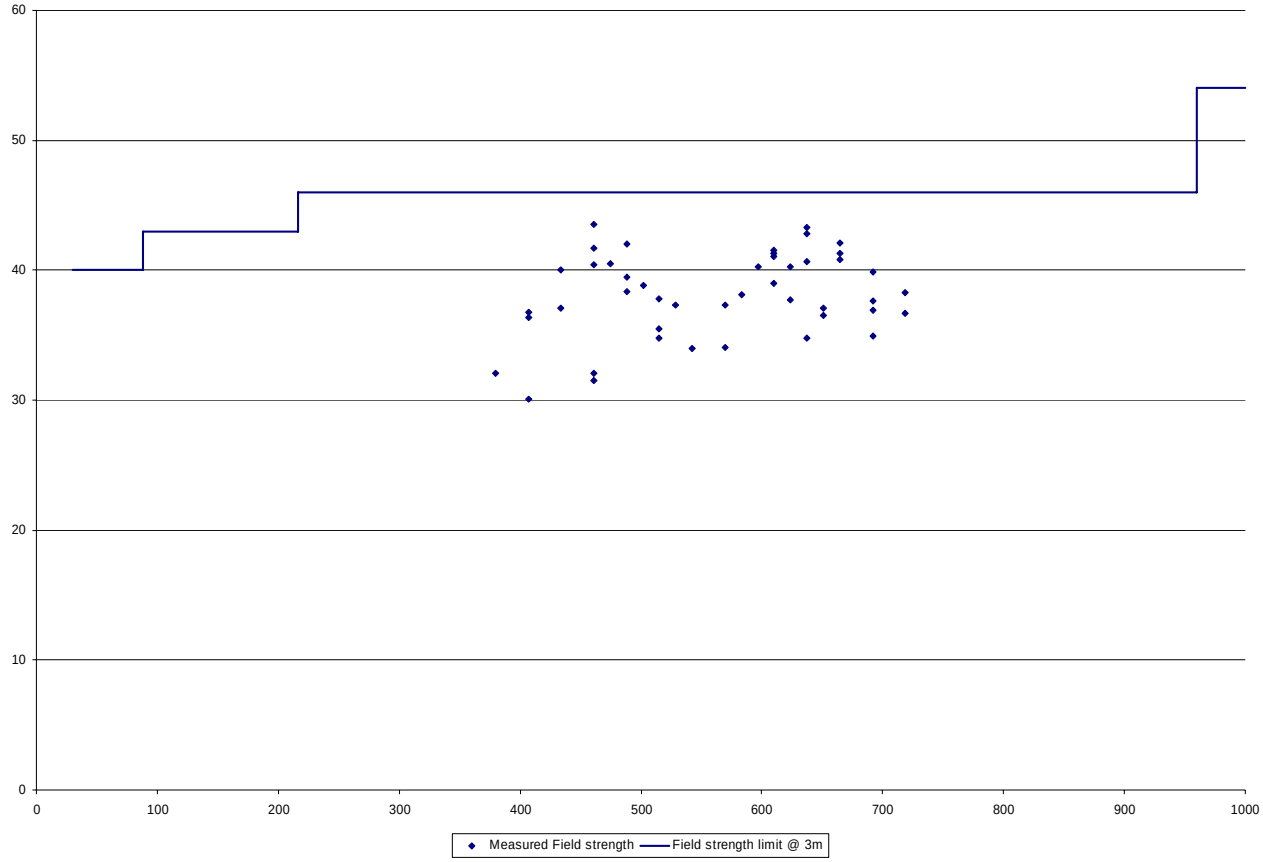
Fre-quency	EUT orientation	Azi mut h	Anten na height	Polari-zation	Instru-ment reading	Detector type	Antenna factor	Cable loss	Amplifier gain	Distance correction	Measured value Peak		Limit Peak	Mar -gin	Result		Correction Average	Calculated value Average		Limit Average	Mar -gin	Result
MHz	-	°	m	-	dB(µV)	-	dB(1/m)	dB	dB	dB	dB(µV/m)	µV/m	dB(µV/m)	dB	-		dB	dB(µV/m)	µV/m	dB(µV/m)	dB	
2401	standing upright	180	1,2	V	86,2	Peak	29,30	2,36	28,51	0,00	89,4	29343	114,0	24,7	pass		-14,8	74,6	5340	94	19,4	pass
2425	standing upright	180	1,2	V	84,76	Peak	29,34	2,38	28,45	0,00	88,0	25206	114,0	26,0	pass		-14,8	73,2	4587	94	20,8	pass
2427	standing upright	180	1,2	V	85,62	Peak	29,34	2,38	28,44	0,00	88,9	27861	114,0	25,1	pass		-14,8	74,1	5071	94	19,9	pass
2452	standing upright	180	1,2	V	82,7	Peak	29,38	2,40	28,38	0,00	86,1	20184	114,0	27,9	pass		-14,8	71,3	3673	94	22,7	pass
2401	lying on the back	0	1,2	V	87,98	Peak	29,30	2,36	28,51	0,00	91,1	36016	114,0	22,9	pass		-14,8	76,3	6555	94	17,7	pass
2425	lying on the back	0	1,2	V	87,76	Peak	29,34	2,38	28,45	0,00	91,0	35604	114,0	23,0	pass		-14,8	76,2	6480	94	17,8	pass
2427	lying on the back	0	1,2	V	87,7	Peak	29,34	2,38	28,44	0,00	91,0	35400	114,0	23,0	pass		-14,8	76,2	6443	94	17,8	pass
2452	lying on the back	0	1,2	V	86,99	Peak	29,38	2,40	28,38	0,00	90,4	33075	114,0	23,6	pass		-14,8	75,6	6020	94	18,4	pass
2401	lying on the side	0	1,2	V	83,11	Peak	29,30	2,36	28,51	0,00	86,3	20559	114,0	27,7	pass		-14,8	71,5	3742	94	22,5	pass
2425	lying on the side	0	1,2	V	82,94	Peak	29,34	2,38	28,45	0,00	86,2	20441	114,0	27,8	pass		-14,8	71,4	3720	94	22,6	pass
2427	lying on the side	0	1,2	V	83,24	Peak	29,34	2,38	28,44	0,00	86,5	21184	114,0	27,5	pass		-14,8	71,7	3855	94	22,3	pass
2452	lying on the side	0	1,2	V	83,19	Peak	29,38	2,40	28,38	0,00	86,6	21355	114,0	27,4	pass		-14,8	71,8	3887	94	22,2	pass
2401	standing upright	180	1,3	H	81,86	Peak	29,30	2,36	28,51	0,00	85,0	17803	114,0	29,0	pass		-14,8	70,2	3240	94	23,8	pass
2425	standing upright	180	1,3	H	81,19	Peak	29,34	2,38	28,45	0,00	84,5	16711	114,0	29,5	pass		-14,8	69,7	3041	94	24,3	pass
2427	standing upright	180	1,3	H	86,05	Peak	29,34	2,38	28,44	0,00	89,3	29275	114,0	24,7	pass		-14,8	74,5	5328	94	19,5	pass
2452	standing upright	180	1,3	H	81,64	Peak	29,38	2,40	28,38	0,00	85,0	17865	114,0	29,0	pass		-14,8	70,2	3251	94	23,8	pass
2401	lying on the back	90	1,3	H	81,29	Peak	29,30	2,36	28,51	0,00	84,4	16672	114,0	29,6	pass		-14,8	69,6	3034	94	24,4	pass
2425	lying on the back	90	1,3	H	78,76	Peak	29,34	2,38	28,45	0,00	82,0	12633	114,0	32,0	pass		-14,8	67,2	2299	94	26,8	pass
2427	lying on the back	90	1,3	H	79,97	Peak	29,34	2,38	28,44	0,00	83,3	14538	114,0	30,8	pass		-14,8	68,5	2646	94	25,5	pass
2452	lying on the back	90	1,3	H	79,84	Peak	29,38	2,40	28,38	0,00	83,2	14521	114,0	30,8	pass		-14,8	68,4	2643	94	25,6	pass
2401	lying on the side	270	1,3	H	79,94	Peak	29,30	2,36	28,51	0,00	83,1	14272	114,0	30,9	pass		-14,8	68,3	2598	94	25,7	pass
2425	lying on the side	270	1,3	H	80,24	Peak	29,34	2,38	28,45	0,00	83,5	14980	114,0	30,5	pass		-14,8	68,7	2726	94	25,3	pass
2427	lying on the side	270	1,3	H	80,16	Peak	29,34	2,38	28,44	0,00	83,4	14859	114,0	30,6	pass		-14,8	68,6	2704	94	25,4	pass
2452	lying on the side	270	1,3	H	79,47	Peak	29,38	2,40	28,38	0,00	82,9	13916	114,0	31,1	pass		-14,8	68,1	2533	94	25,9	pass

Fre-quency	EUT orientation	Azi mut h	Anten na height	Polari-zation	Instru-ment reading	Detector type	Antenna factor	Cable loss	Amplifier gain	Distance correction	Measured value Peak		Limit Peak	Mar -gin	Result		Correction Average	Calculated value Average		Limit Average	Mar -gin	Result
MHz	-	°	m	-	dB(µV)	-	dB(1/m)	dB	dB	dB	dB(µV/m)	µV/m	dB(µV/m)	dB	-		dB	dB(µV/m)	µV/m	dB(µV/m)	dB	
4802	standing upright	300	1,3	H	46,75	Peak	35,80	0,00	28,08	0,00	54,5	529	74,0	19,5	pass		-14,8	39,7	96	54	14,3	pass
4850	standing upright	300	1,3	H	47,03	Peak	35,78	0,00	28,21	0,00	54,6	537	74,0	19,4	pass		-14,8	39,8	98	54	14,2	pass
4854	standing upright	300	1,3	H	48,03	Peak	35,77	0,00	28,20	0,00	55,6	603	74,0	18,4	pass		-14,8	40,8	110	54	13,2	pass
4904	standing upright	300	1,3	H	46,41	Peak	35,70	0,00	28,13	0,00	54,0	500	74,0	20,0	pass		-14,8	39,2	91	54	14,8	pass
7203	standing upright	0	1,5	H	46,30	Peak	36,73	0,00	27,04	0,00	56,0	630	74,0	18,0	pass		-14,8	41,2	115	54	12,8	pass
7275	standing upright	0	1,5	H	45,24	Peak	36,81	0,00	27,06	0,00	55,0	562	74,0	19,0	pass		-14,8	40,2	102	54	13,8	pass
7281	standing upright	0	1,5	H	45,10	Peak	36,81	0,00	27,05	0,00	54,9	553	74,0	19,1	pass		-14,8	40,1	101	54	13,9	pass
7356	standing upright	0	1,5	H	45,38	Peak	36,82	0,00	27,08	0,00	55,1	570	74,0	18,9	pass		-14,8	40,3	104	54	13,7	pass
4802	standing upright	300	1,7	V	49,89	Peak	35,80	0,00	28,08	0,00	57,6	759	74,0	16,4	pass		-14,8	42,8	138	54	11,2	pass
4850	standing upright	300	1,7	V	50,29	Peak	35,78	0,00	28,21	0,00	57,9	782	74,0	16,1	pass		-14,8	43,1	142	54	10,9	pass
4854	standing upright	300	1,7	V	49,40	Peak	35,77	0,00	28,20	0,00	57,0	706	74,0	17,0	pass		-14,8	42,2	128	54	11,8	pass
4904	standing upright	300	1,7	V	47,94	Peak	35,70	0,00	28,13	0,00	55,5	596	74,0	18,5	pass		-14,8	40,7	109	54	13,3	pass
7203	standing upright	210	1,7	V	47,66	Peak	36,73	0,00	27,04	0,00	57,4	737	74,0	16,7	pass		-14,8	42,6	134	54	11,4	pass
7275	standing upright	210	1,7	V	46,03	Peak	36,81	0,00	27,06	0,00	55,8	615	74,0	18,2	pass		-14,8	41,0	112	54	13,0	pass
7281	standing upright	210	1,7	V	46,10	Peak	36,81	0,00	27,05	0,00	55,9	621	74,0	18,1	pass		-14,8	41,1	113	54	12,9	pass
7356	standing upright	210	1,7	V	42,62	Peak	36,82	0,00	27,08	0,00	52,4	415	74,0	21,6	pass		-14,8	37,6	76	54	16,4	pass
4802	lying on the side	0	2	H	46,42	Peak	35,80	0,00	28,08	0,00	54,1	509	74,0	19,9	pass		-14,8	39,3	93	54	14,7	pass
4850	lying on the side	0	2	H	46,91	Peak	35,78	0,00	28,21	0,00	54,5	530	74,0	19,5	pass		-14,8	39,7	96	54	14,3	pass
4854	lying on the side	0	2	H	47,12	Peak	35,77	0,00	28,20	0,00	54,7	543	74,0	19,3	pass		-14,8	39,9	99	54	14,1	pass
4904	lying on the side	0	2	H	47,31	Peak	35,70	0,00	28,13	0,00	54,9	555	74,0	19,1	pass		-14,8	40,1	101	54	13,9	pass
7203	lying on the side	0	1,3	H	44,25	Peak	36,73	0,00	27,04	0,00	53,9	498	74,0	20,1	pass		-14,8	39,1	91	54	14,9	pass
7275	lying on the side	0	1,3	H	43,00	Peak	36,81	0,00	27,06	0,00	52,8	434	74,0	21,3	pass		-14,8	38,0	79	54	16,0	pass
7281	lying on the side	0	1,3	H	42,01	Peak	36,81	0,00	27,05	0,00	51,8	388	74,0	22,2	pass		-14,8	37,0	71	54	17,0	pass
7356	lying on the side	0	1,3	H	43,19	Peak	36,82	0,00	27,08	0,00	52,9	443	74,0	21,1	pass		-14,8	38,1	81	54	15,9	pass
4802	lying on the side	90	1,7	V	45,16	Peak	35,80	0,00	28,08	0,00	52,9	441	74,0	21,1	pass		-14,8	38,1	80	54	15,9	pass
4850	lying on the side	90	1,7	V	43,96	Peak	35,78	0,00	28,21	0,00	51,5	377	74,0	22,5	pass		-14,8	36,7	69	54	17,3	pass
4854	lying on the side	90	1,7	V	45,04	Peak	35,77	0,00	28,20	0,00	52,6	427	74,0	21,4	pass		-14,8	37,8	78	54	16,2	pass
4904	lying on the side	90	1,7	V	45,37	Peak	35,70	0,00	28,13	0,00	52,9	444	74,0	21,1	pass		-14,8	38,1	81	54	15,9	pass
7203	lying on the side	90	1,5	V	46,42	Peak	36,73	0,00	27,04	0,00	56,1	639	74,0	17,9	pass		-14,8	41,3	116	54	12,7	pass
7275	lying on the side	90	1,5	V	45,10	Peak	36,81	0,00	27,06	0,00	54,9	553	74,0	19,2	pass		-14,8	40,1	101	54	13,9	pass
7281	lying on the side	90	1,5	V	45,16	Peak	36,81	0,00	27,05	0,00	54,9	557	74,0	19,1	pass		-14,8	40,1	101	54	13,9	pass
7356	lying on the side	90	1,5	V	46,38	Peak	36,82	0,00	27,08	0,00	56,1	640	74,0	17,9	pass		-14,8	41,3	116	54	12,7	pass

Frequency	EUT orientation	Azimuth	Antenna height	Polarization	Instrument reading	Detector type	Antenna factor	Cable loss	Amplifier gain	Distance correction	Measured value Peak		Limit Peak	Margin	Result		Correction Average	Calculated value Average		Limit Average	Margin	Result
MHz	-	°	m	-	dB(µV)	-	dB(1/m)	dB	dB	dB	dB(µV/m)	µV/m	dB(µV/m)	dB	-		dB	dB(µV/m)	µV/m	dB(µV/m)	dB	
4802	lying on the back	90	2	H	46,64	Peak	35,80	0,00	28,08	0,00	54,4	522	74,0	19,6	pass		-14,8	39,6	95	54	14,4	pass
4850	lying on the back	90	2	H	47,86	Peak	35,78	0,00	28,21	0,00	55,4	591	74,0	18,6	pass		-14,8	40,6	108	54	13,4	pass
4854	lying on the back	90	2	H	47,25	Peak	35,77	0,00	28,20	0,00	54,8	551	74,0	19,2	pass		-14,8	40,0	100	54	14,0	pass
4904	lying on the back	90	2	H	45,20	Peak	35,70	0,00	28,13	0,00	52,8	435	74,0	21,2	pass		-14,8	38,0	79	54	16,0	pass
7203	lying on the back	90	1,3	H	42,92	Peak	36,73	0,00	27,04	0,00	52,6	427	74,0	21,4	pass		-14,8	37,8	78	54	16,2	pass
7275	lying on the back	90	1,3	H	41,95	Peak	36,81	0,00	27,06	0,00	51,7	385	74,0	22,3	pass		-14,8	36,9	70	54	17,1	pass
7281	lying on the back	90	1,3	H	42,06	Peak	36,81	0,00	27,05	0,00	51,8	390	74,0	22,2	pass		-14,8	37,0	71	54	17,0	pass
7356	lying on the back	90	1,3	H	42,29	Peak	36,82	0,00	27,08	0,00	52,0	399	74,0	22,0	pass		-14,8	37,2	73	54	16,8	pass
4802	lying on the back	60	1,7	V	47,59	Peak	35,80	0,00	28,08	0,00	55,3	583	74,0	18,7	pass		-14,8	40,5	106	54	13,5	pass
4850	lying on the back	60	1,7	V	48,58	Peak	35,78	0,00	28,21	0,00	56,2	642	74,0	17,9	pass		-14,8	41,4	117	54	12,6	pass
4854	lying on the back	60	1,7	V	47,30	Peak	35,77	0,00	28,20	0,00	54,9	554	74,0	19,1	pass		-14,8	40,1	101	54	13,9	pass
4904	lying on the back	60	1,7	V	48,60	Peak	35,70	0,00	28,13	0,00	56,2	643	74,0	17,8	pass		-14,8	41,4	117	54	12,6	pass
7203	lying on the back	180	1,5	V	44,62	Peak	36,73	0,00	27,04	0,00	54,3	519	74,0	19,7	pass		-14,8	39,5	95	54	14,5	pass
7275	lying on the back	180	1,5	V	43,29	Peak	36,81	0,00	27,06	0,00	53,0	449	74,0	21,0	pass		-14,8	38,2	82	54	15,8	pass
7281	lying on the back	180	1,5	V	42,85	Peak	36,81	0,00	27,05	0,00	12,6	4	74,0	61,4	pass		-14,8	-2,2	1	54	56,2	pass
7356	lying on the back	180	1,5	V	43,95	Peak	36,82	0,00	27,08	0,00	53,7	484	74,0	20,3	pass		-14,8	38,9	88	54	15,1	pass

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	Azimuth CCW 1°	Reading dB(µV)	Antenna-factor dB/m	Distance correction dB	Σ dB(µV/m)	Limit dB(µV/m)	Margin dB	Result	Remarks
406,85	10	1	Ver.	90	7,4	18,93	10,46	36,79	46	9,21	PASS	standing upright
433,97	10	1	Ver.	90	10	19,55	10,46	40,01	46	5,99	PASS	standing upright
461,09	10	3,5	Ver.	330	10,4	19,57	10,46	40,43	46	5,57	PASS	standing upright
488,22	10	3,4	Ver.	330	7,4	20,53	10,46	38,39	46	7,61	PASS	standing upright
515,33	10	3,5	Ver.	0	3,3	21	10,46	34,76	46	11,24	PASS	standing upright
542,46	10	3,3	Ver.	0	2,2	21,34	10,46	34	46	12	PASS	standing upright
569,59	10	2,9	Ver.	50	1,5	22,09	10,46	34,05	46	11,95	PASS	standing upright
610,27	10	3,1	Ver.	150	5,5	23,07	10,46	39,03	46	6,97	PASS	standing upright
637,4	10	2,8	Ver.	150	6,8	23,42	10,46	40,68	46	5,32	PASS	standing upright
650,955	10	2,4	Ver.	135	2,5	23,56	10,46	36,52	46	9,48	PASS	standing upright

Frequency MHz	Distance m	Height of Antenna m	Polarization	Azimuth CCW 1°	Reading dB(µV)	Antenna-factor dB/m	Distance correction dB	Σ dB(µV/m)	Limit dB(µV/m)	Margin dB	Result	Remarks
664,52	10	2,4	Ver.	210	7,2	23,65	10,46	41,31	46	4,69	PASS	standing upright
691,64	10	2,3	Ver.	210	5,5	23,9	10,46	39,86	46	6,14	PASS	standing upright
718,76	10	2,3	Ver.	210	3,3	24,55	10,46	38,31	46	7,69	PASS	standing upright
379,72	10	1	Ver.	90	3,5	18,07	10,46	32,03	46	13,97	PASS	standing upright
691,64	10	1,3	Hor.	50	0,6	23,9	10,46	34,96	46	11,04	PASS	standing upright
718,76	10	1,2	Hor.	0	1,7	24,55	10,46	36,71	46	9,29	PASS	standing upright
406,85	10	3	Hor.	0	7	18,93	10,46	36,39	46	9,61	PASS	lying on the back
433,97	10	3	Hor.	0	7,1	19,55	10,46	37,11	46	8,89	PASS	lying on the back
461,09	10	2,5	Hor.	0	11,7	19,57	10,46	41,73	46	4,27	PASS	lying on the back
488,21	10	1,8	Hor.	180	8,5	20,53	10,46	39,49	46	6,51	PASS	lying on the back
515,34	10	2,4	Hor.	180	4	21	10,46	35,46	46	10,54	PASS	lying on the back
569,58	10	1,5	Hor.	180	4,8	22,09	10,46	37,35	46	8,65	PASS	lying on the back
583,144	10	1,4	Hor.	180	5,2	22,48	10,46	38,14	46	7,86	PASS	lying on the back
596,7	10	1,4	Hor.	0	7	22,83	10,46	40,29	46	5,71	PASS	lying on the back
610,27	10	2	Hor.	0	7,5	23,07	10,46	41,03	46	4,97	PASS	lying on the back
610,27	10	2	Hor.	210	7,8	23,07	10,46	41,33	46	4,67	PASS	lying on the back
623,83	10	2	Hor.	210	6,5	23,27	10,46	40,23	46	5,77	PASS	lying on the back
637,39	10	1,4	Hor.	150	9,4	23,42	10,46	43,28	46	2,72	PASS	lying on the back
650,95	10	1,6	Hor.	150	3,1	23,56	10,46	37,12	46	8,88	PASS	lying on the back
664,51	10	1,6	Hor.	150	6,7	23,65	10,46	40,81	46	5,19	PASS	lying on the back
691,64	10	1,2	Hor.	180	3,3	23,9	10,46	37,66	46	8,34	PASS	lying on the back
637,39	10	3,5	Ver.	90	0,9	23,42	10,46	34,78	46	11,22	PASS	lying on the back
461,09	10	3,2	Ver.	90	1,5	19,57	10,46	31,53	46	14,47	PASS	lying on the back
461,09	10	2,4	Hor.	0	13,5	19,57	10,46	43,53	46	2,47	PASS	lying on the side
474,65	10	2,3	Hor.	0	9,9	20,13	10,46	40,49	46	5,51	PASS	lying on the side
488,21	10	1,9	Hor.	0	11	20,53	10,46	41,99	46	4,01	PASS	lying on the side
501,77	10	2,2	Hor.	330	7,6	20,81	10,46	38,87	46	7,13	PASS	lying on the side
515,33	10	2,2	Hor.	330	6,3	21	10,46	37,76	46	8,24	PASS	lying on the side
528,89	10	1,7	Hor.	0	5,7	21,18	10,46	37,34	46	8,66	PASS	lying on the side
637,39	10	1,6	Hor.	150	8,9	23,42	10,46	42,78	46	3,22	PASS	lying on the side
610,27	10	1,9	Hor.	150	8	23,07	10,46	41,53	46	4,47	PASS	lying on the side
623,83	10	2	Hor.	150	4	23,27	10,46	37,73	46	8,27	PASS	lying on the side

Frequency MHz	Distance m	Height of Antenna m	Polarization	Azimuth CCW 1°	Reading dB(µV)	Antenna-factor dB/m	Distance correction dB	Σ dB(µV/m)	Limit dB(µV/m)	Margin dB	Result	Remarks
664,51	10	1,6	Hor.	150	8	23,65	10,46	42,11	46	3,89	PASS	lying on the side
691,64	10	1,8	Hor.	150	2,6	23,9	10,46	36,96	46	9,04	PASS	lying on the side
406,85	10	3	Ver.	300	0,7	18,93	10,46	30,09	46	15,91	PASS	lying on the side
461,09	10	3	Ver.	90	2	19,57	10,46	32,03	46	13,97	PASS	lying on the side

Explanations concerning the EUT azimuth:
Standing upright: 0° = Display of the EUT facing the antenna
Lying on the back: 90° = Bottom of the EUT facing the antenna
Lying on the side: 270° = Bottom of the EUT facing the antenna

5 Photographs

Figure 1

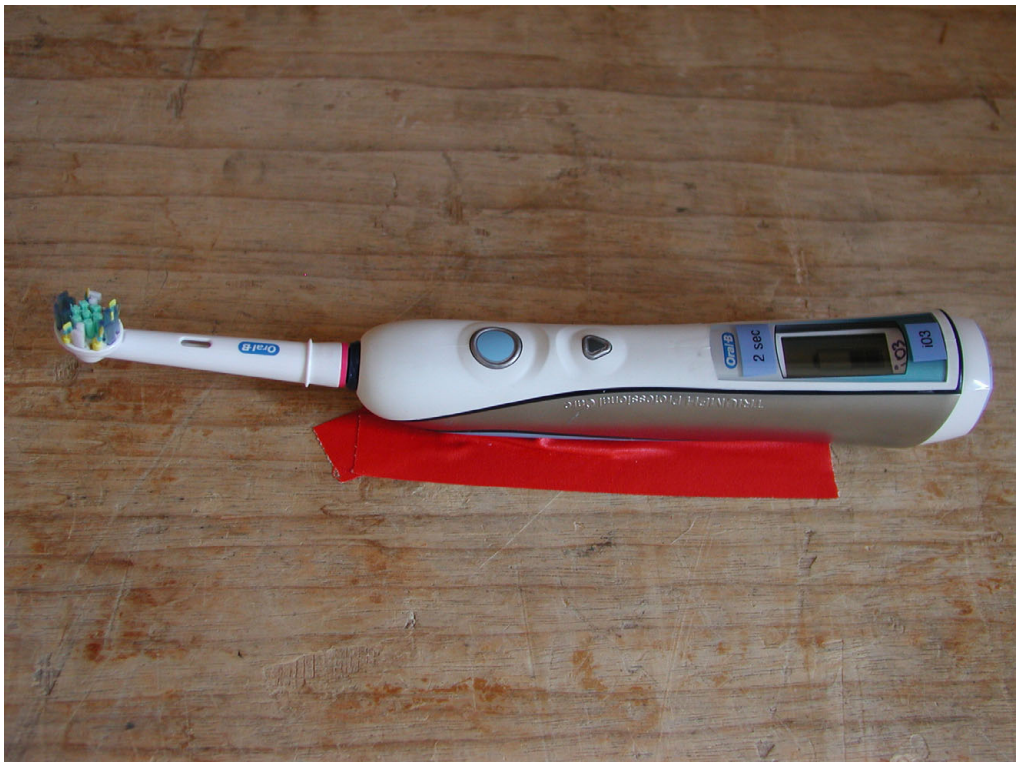


Figure 2

Figure 3

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