

TEST REPORT # EMCC-011166ECA 2015-10-19

EQUIPMENT UNDER TEST:

Trade Name: Genius
Component: Motorbrake
Type: T2080 Genius
Serial No: Sample #3, 211302873,
Sample #4, 211301490
Equipment Category: Short Range Equipment
Application: Motorbrake with Wireless Data Transfer
Manufacturer: EBE Elektro-Bau-Elemente GmbH
Address: Sielminger Straße 63
70771 Leinfelden-Echterdingen
Germany
Applicant: EBE Elektro-Bau-Elemente GmbH
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RELEVANT STANDARD(S): 47 CFR Part 15C

MEASUREMENT PROCEDURE USED:

ANSI C63.4-2009 RSS-Gen Issue 3 Other: ANSI C63.10-2009

TEST REPORT PREPARED BY:

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Ludwig Kraft

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1 GENERAL INFORMATION

1.1 Purpose

The purpose of this report is to show compliance to the FCC regulations for unlicensed devices operating under section 15.249 of the Code of Federal Regulations title 47.

1.2 Limits and Reservations

The test results in this report apply only to the particular Equipment Under Test (EUT) as declared in this report. This test report shall not be reproduced except in full without the written permission of EMCCons DR. RAŠEK GmbH & Co. KG.

1.3 Test Location

Company Name:	EMCCons DR. RAŠEK GmbH & Co. KG
Street:	Moggast, Boelwiese 8
City:	91320 Ebermannstadt
Country:	Germany
Address of Labs I, II, III and Head Office:	EMCCons DR. RAŠEK GmbH & Co. KG Moggast, Boelwiese 8 91320 Ebermannstadt Germany
Address of Labs IV and V:	EMCCons DR. RAŠEK GmbH & Co. KG Stoernhofer Berg 15 91364 Unterleinleiter Germany
Test Laboratory:	EMCCons DR. RAŠEK GmbH & Co. KG, Test Laboratory IV located at Stoernhofer Berg 15, 91364 Unterleinleiter, Germany the 3 m & 10 m semi-anechoic chamber site has been fully described in the report submitted to the FCC, and accepted in the letter dated December 22, 2010, Registration Number 878769.
Name for contact purposes:	Mr Ludwig Kraft
Phone:	+49 9194 9016
Fax:	+49 9194 8125
E-Mail:	l.kraft@emcc.de
Web:	www.emcc.de

1.4 Manufacturer

Company Name:	EBE Elektro-Bau-Elemente GmbH
Street:	Sielminger Straße 63
City:	70771 Leinfelden-Echterdingen
Country:	Germany

1.5 Applicant

Company Name: EBE Elektro-Bau-Elemente GmbH
Street: Sielminger Straße 63
City: 70771 Leinfelden-Echterdingen
Country: Germany

Name for contact purposes: Mr Alexander Bräckle
Phone: +49 711 79986-285
E-mail: alexander.braeckle@ebe-gmbh.de

1.6 Dates

Date of receipt of EUT: Sample #3 CW 24/2015, Sample # 4 CW 37/2015
Test Date: see table below

1.7 Ordering Information

Purchase Order and Date: 163813, dated 2015-03-15
Vendor Number: 209576

1.8 Climatic Conditions

Date	Temperature [°C]	Relative Humidity [%]	Air Pressure [hPa]	Lab	Customer attended tests
2015-07-20	28	47	975	IV	no
2015-07-21	28	50	975	IV	no
2015-09-17	25	49	962	IV	no
2015-09-21	23	44	977	IV	no
2015-09-25	24	42	980	IV	no
2015-09-28	23	38	993	IV	no
2015-10-23	23	41	983	IV	no

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

Trade name:	Genius
Component:	Motorbrake
Type:	T2080 Genius
Serial No.:	Sample #3, 211302873 Sample #4, 211301490
FCC ID	2AAMI-T2080
Application:	Motorbrake with Wireless Data Transfer
Power:	110 – 230 VAC
Radio Technologie	ANT
TX operating frequency:	2460 MHz
TX rated output power:	≤ 0dBm e.i.r.p. ¹
Modulation:	GMSK*
Lowest frequency in EUT:	4 MHz
Antenna:	Internal, integral
Interface ports:	None
Variants:	None

2.2 Intended Use

The Genius Motorbrake is part of the Genius Trainer system.

The Genius Motorbrake is linked via ANT protocol with the control PC running the application software.



Photograph 2.2-1: EUT in VR Trainer application [photo taken from product website]

¹ As specified by the manufacturer.

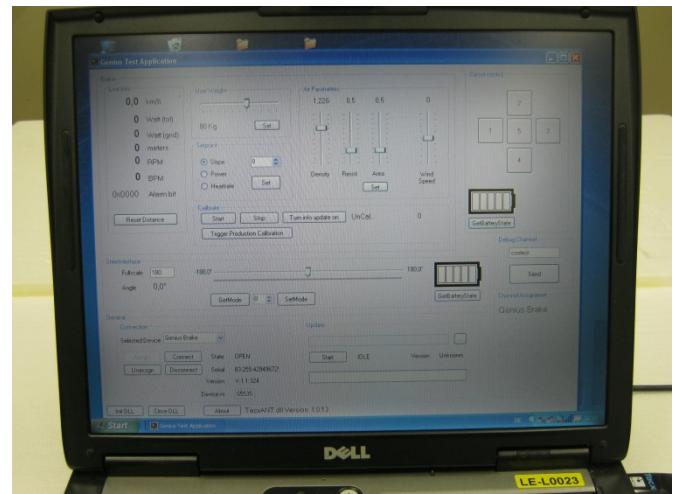
2.3 EUT Peripherals / Simulators

The following devices were used for setting the appropriate test modi:

- ANT+ USB Stick (provided by the manufacturer)
- Laptop PC (provided by the manufacturer) used for test mode running
- Application software (Genius Test Application, Version: 1.0.13 provided by manufacturer)
- Adapter cable with USB - RS232 converter



Photograph 2.3-1: Laptop PC with application software and ANT USB Stick used for test mode running



Photograph 2.3-2: Screenshot of the application software used for the test mode running

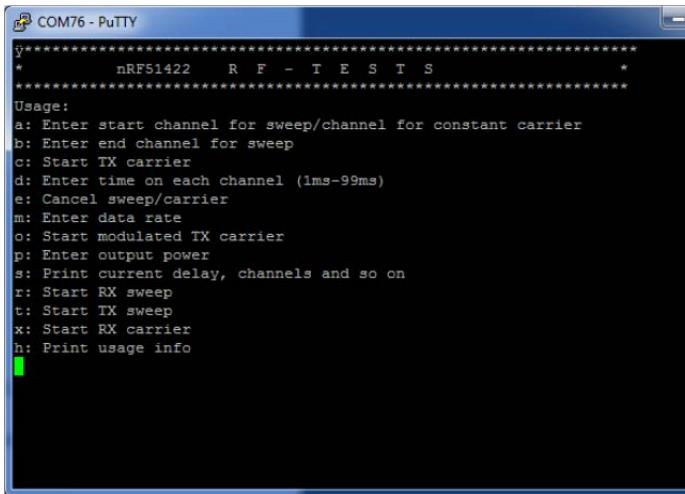


Photograph 2.3-3: Top view of ANT+ USB Stick used for test mode running



Photograph 2.3-4: Rear view of ANT+ USB Stick used for test mode running

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C



```
COM76 - PuTTY
*****
*      nRF51422      R F - T E S T S      *
*****
Usage:
a: Enter start channel for sweep/channel for constant carrier
b: Enter end channel for sweep
c: Start TX carrier
d: Enter time on each channel (1ms-99ms)
e: Cancel sweep/carrier
m: Enter data rate
o: Start modulated TX carrier
p: Enter output power
s: Print current delay, channels and so on
r: Start RX sweep
t: Start TX sweep
x: Start RX carrier
h: Print usage info
```

Photograph 2.3-5: Screen shot of the terminal programm with the RF Test software used for the configuration of the RF transmitter in mode CW and modulated



Photograph 2.3-6: Connector cable with USB to serial converter and connector to the RF PCB used for the mode CW and modulated for test purpose, only

2.4 Mode of Operation during Testing

The EUT test mode running was set via ANT USB device and Genius Test Application software. The software was running on the Laptop PC with the ANT USB device connected.

The CW mode and modulated mode were configured with a test firmware provided by the customer. The EUT was configured with a terminal connected via a USB cable and an USB to serial converter (photograph 2.3-6). The cable and the converter were provide for the test and are not part of the EUT.

The EUT was operated in a special CW test mode and in modulated test mode with random data, as provided by the customer. The configured modulation in mode 4 represents the modulation used in normal operation mode according to the customer.

Mode 1: standby

The EUT enters automatically the standby mode about 10 s after power on.
This mode was tested with EUT Sample #3.

Mode 2: running

This mode simulates a downhill bicycle ride with about 50 km/h. This mode was setup with the Genius Test Application software via Laptop and the ANT+ USB stick connected. The commands "contest" and "calsrt" were executed on the Genius Test Application to start this test mode.

This mode was tested with EUT Sample #3.

Mode 3: CW mode

The CW mode was tested with EUT Sample #4. Find below the configuration commands provided by the customer for CW mode.

“

Required Test Signal: Continuous Wave (CW) - TX Carrier without modulation (+4dBm, Channels 02, 80)

“a02” -> set frequency to 2402 MHz (or set other Channel as required)

“c” -> Start CW TX (carrier without modulation)

“

Mode 4: modulated

The modulated mode was tested with EUT Sample #4. Find below the configuration commands provided by the customer for the Tx modulated mode.

“

Required Test Signal: Continuous TX Modulated (1 Mbit/s +4dBm, Channels 02, 50, 80)

Operation:

Output Power +4dBm and Data Rate 1 Mbit/s is default...

After Power On Reset enter:

“a02” -> set frequency to 2402 MHz (or set other Channel as required)

“o” -> Start modulated TX carrier

“

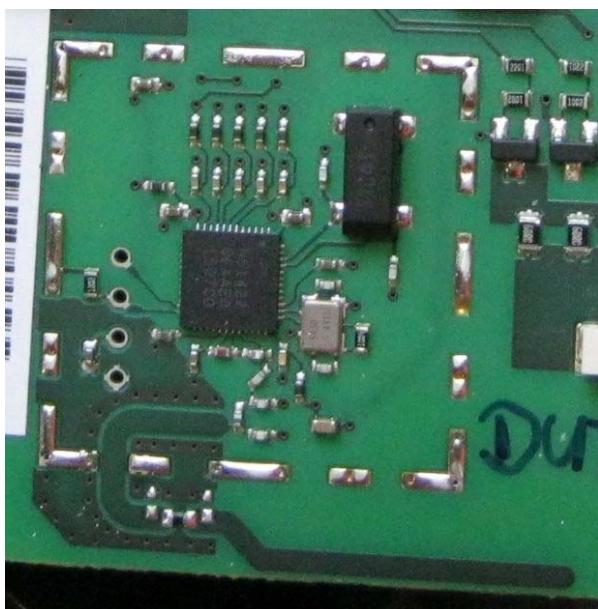
2.5 Modifications required for Compliance

Modification 1:

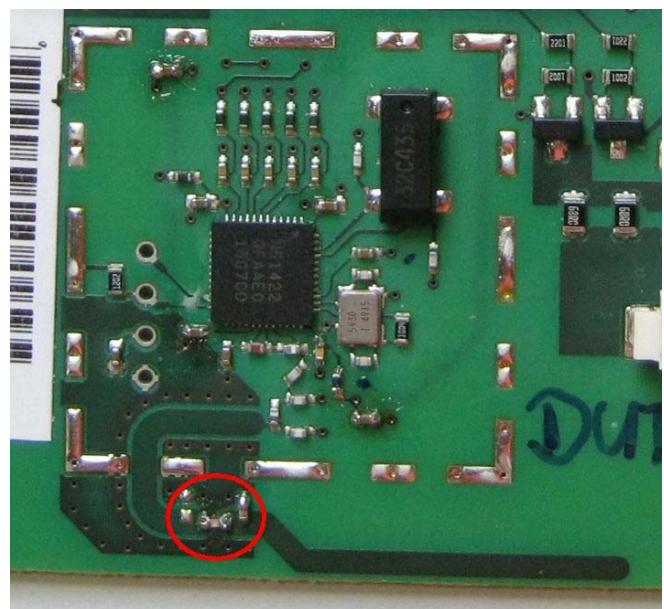
An LC Filter was added in the RF path to the antenna on the PCB board, see pictures below of the PCB board before and after the modification. In addition the output power configured at the RF chip was reduced from 4 dBm initially used to 0dBm. The command "p1" was executed on the terminal after setting the frequency.

Command example:

"p1": set output power to 0dBm



Photograph 2.6-1: Detail of PCP of EUT sample #4 before modification



Photograph 2.6-2: Detail of PCP of EUT sample #4 with modification

The modification was done on Sample #4, only.

The modification was required for compliance with spurious emissions requirement.

3 TEST RESULTS SUMMARY

Summary of test results for the following EUT:

Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: Genius Motorbrake
Type: T2080 Genius
Serial Number: Sample #3, 211302873
Sample #4, 211301490

Requirement	47 CFR Section	Report Section	Test Result
Antenna Requirement	15.203	4	Compliant Sample #3, Sample #4
AC Line Conducted Emissions	15.207	5	Compliant Sample #3
Field Strength Limits (Fundamental)	15.249	6	Compliant Sample #4
Radiated Spurious Emissions	15.249, 15.209, 15.205(b)	7	Compliant Sample #3 (150 kHz -1000 MHz), Sample #4 (30 MHz -25 GHz)
Band-edge Emissions	15.249	8	Compliant Sample #4
Emission Bandwidth (20 dB Bandwidth)	15.215	9	Compliant Sample #4

N.A. – Not applicable.

The client has made the determination that EUT condition, characterization, and mode of operation are representative of production units, and meet the requirements of the specifications referenced herein.

Consistent with Industry practice, measurement and test equipment not directly involved in obtaining measurement results but having an impact on measurements (such as cable loss, antenna factors, etc.) are factored into the "Correction Factor" documented in certain test results. Instrumentation employed for testing meets tolerances consistent with known Industry Standards and Regulations.

The measurements contained in this report were made in accordance with the procedures in ANSI C63.4 – 2009 & ANSI C63.10 – 2009 and all applicable Public Notices received prior to the date of testing. All emissions from the device were found to be within the limits outlined in this report.

The test results in this report apply only to the particular equipment under test (EUT) as declared in this report.

Test Personnel: Ludwig Kraft
Issuance Date: 2015-10-19

4 ANTENNA REQUIREMENT

Test Requirement: FCC 47 CFR, Part 15C

4.1 Regulation

§15.203

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

4.2 Result

Manufacturer: EBE Elektro-Bau-Elemente GmbH

Device: Genius Motorbrake

Type: T2080 Genius

Serial Number: Sample #3, Sample #4

The antenna is a permanently attached internal antenna.

The EUT meets the requirements of this section.

5 CONDUCTED EMISSIONS TEST

Test Requirement: FCC 47 CFR, Part 15C

Test Procedure: ANSI C63.4-2009

5.1 Regulation

§15.207

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator 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 limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak (QP)	Average (AV)
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.

§15.207

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of battery chargers which permit operating while charging, AC adaptors or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

5.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	Rohde & Schwarz ESU8	3846	2015-08	2016-08
V-LISN 50 ohms//(50 μ H + 5 ohms)	Rohde & Schwarz ESH2-Z5	1901	2015-09	2017-09
Pulse Limiter	Rohde & Schwarz ESH-Z2	1519	2015-09	2017-09
AC Power Source	AEG	0001	N.A.	N.A.
Multimeter	Agilent U1241A	2720	2015-01	2017-01

5.3 Test Procedures

For tabletop equipment, the EUT is placed on a 1 meter by 1.5 meters wide and 0.8 meter high nonconductive table that is placed above the groundplane. Ceiling or wall-mounted devices also is positioned on a tabletop for testing purposes. Floor standing equipment is placed either directly on the groundplane or on insulating material if normally placed on a nonconducting floor. The EUT is connected to its associated peripherals, with any excess I/O cabling bundled to approximately 1 meter. The EUT is

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

connected to a dedicated LISN and all peripherals are connected to a second separate LISN circuit [NA]. The LISNs are bonded to the groundplane.

Conducted measurements are made on each current carrying conductor with respect to ground.

The EUT was tested as floor standing equipment placed on insulating material (1 cm height) plus additional spacer (5 cm insulating material) in order to establish a distance to ground as in real application. Test performed in "standby" and in "motor running" mode.

5.4 Test Results

EUT mode	Freq	Line	Detector	Result	Limit	Margin
	MHz			dB μ V	dB μ V	db
running	0.155	N	AV	46.0	55.7	9.7
running	0.185	N	AV	42.0	54.3	12.3
running	0.200	N	AV	39.1	53.6	14.5
running	0.170	N	QP	50.0	65.0	14.9
running	0.185	N	QP	47.2	64.3	17.0
running	0.230	N	AV	33.9	52.5	18.6
running	0.150	L	AV	49.0	56.0	7.0
running	0.185	L	AV	42.8	54.3	11.5
running	0.155	L	QP	53.0	65.7	12.7
running	0.200	L	AV	40.3	53.6	13.3
running	0.240	L	AV	35.3	52.1	16.8
running	0.175	L	QP	47.0	64.7	17.7

The table above contains worst-case emission, only. For further details refer to the measurement plots below

Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: Genius Motorbrake
Type: T2080 Genius
Serial Number: Sample #3

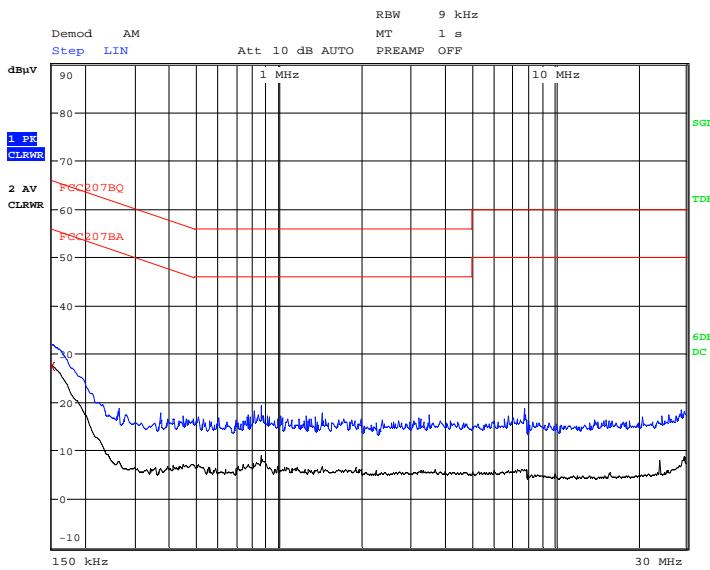
All emissions were found to be below the applicable limits.
The EUT meets the requirements of this section.

Test Personnel: Ludwig Kraft
Test Date: 2015-07-20

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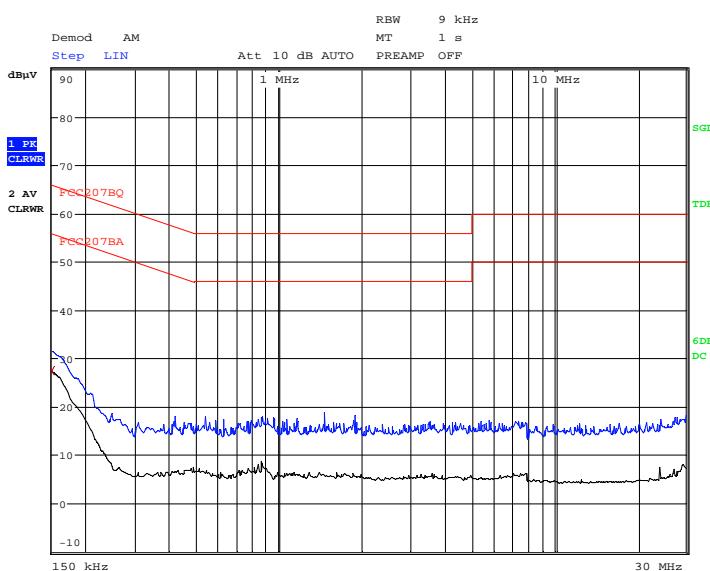
5.5 Measurement Plots

Test in mode 1 (standby) on line N:



Manufacturer: EBE, EUT: #3, Mode: standby, Power: 115 Vac / 60 Hz, Line: N
Date: 20.JUL.2015 15:07:43

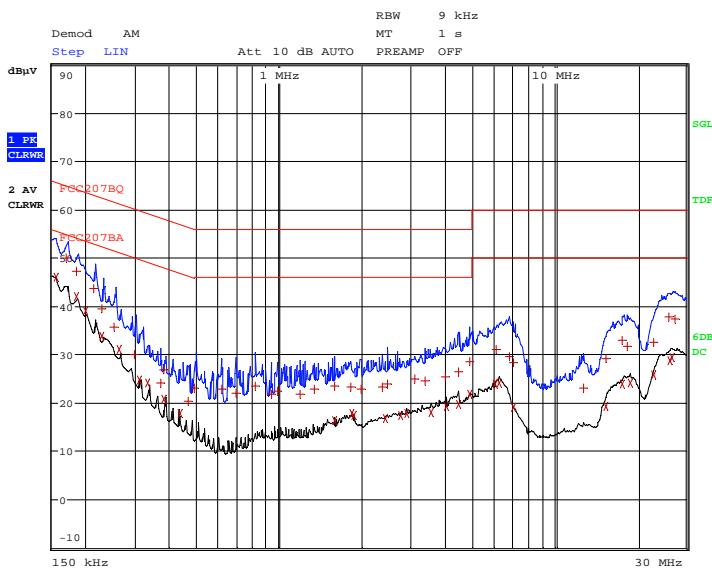
Test in mode 1 (standby) on line L:



Manufacturer: EBE, EUT: #3, Mode: standby, Power: 115 Vac / 60 Hz, Line: L
Date: 20.JUL.2015 15:07:00

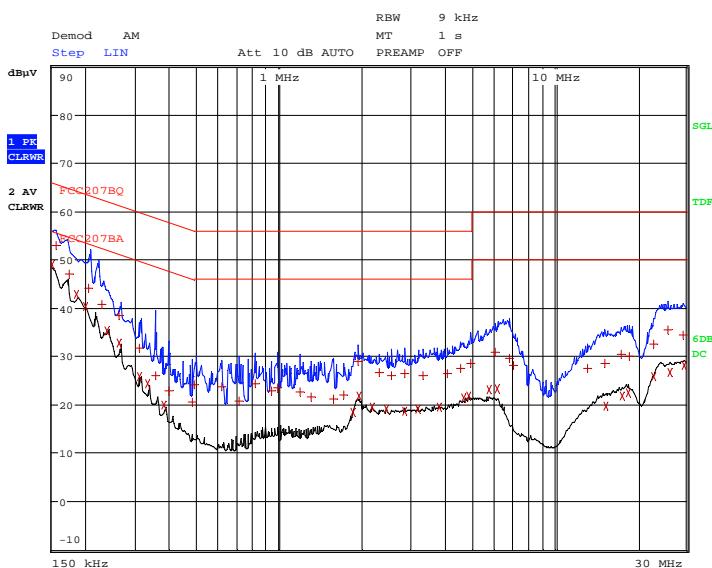
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Test in mode 2 (running) on line N:



Manufacturer: EBE, EUT: #3, Mode: running, Power: 115 Vac /
60 Hz, Line: N
Date: 20.JUL.2015 15:19:47

Test in mode 2 (running) on line N:



Manufacturer: EBE, EUT: #3, Mode: running, Power: 115 Vac /
60 Hz, Line: L
Date: 20.JUL.2015 15:25:51

6 FIELD STRENGTH LIMITS (FUNDAMENTAL)

Test Requirement: FCC 47 CFR, §15.249

Test Procedure: ANSI C63.4-2009

6.1 Regulation

§ 15.249

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental	Field strength of harmonics
	(millivolts/meter)	(microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

(c) Field strength limits are specified at a distance of 3 meters.

(e) As shown in § 15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.

6.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
Spectrum Analyser	Rohde & Schwarz FSU	3831	2015-07	2016-07
Double Ridged Guide Ant.	Schwarzbeck BBHA 9120D	3235	2015-06	2017-06

6.3 Test Procedures

The EUT was tested on a 1.5 meter high non-conductive support for appropriate alignment with the receive antenna.

With the EUT operating in a fixed transmitting frequency mode, emissions from the unit are maximized by adjusting the polarization of the receive antenna and rotating the EUT on the turntable. Worst case emissions are listed under chapter: Test Results.

Radiated emissions test characteristics above 1000 MHz	
Operating mode	Tx at 2460 MHz
Test distance	3 m
Test instrumentation resolution bandwidth	1 MHz
Test instrumentation video bandwidth	3 MHz (10 Hz*)
Receive antenna polarization	Vertical/Horizontal

*: Average measurement was performed with a 10 Hz video bandwidth (video averaging).

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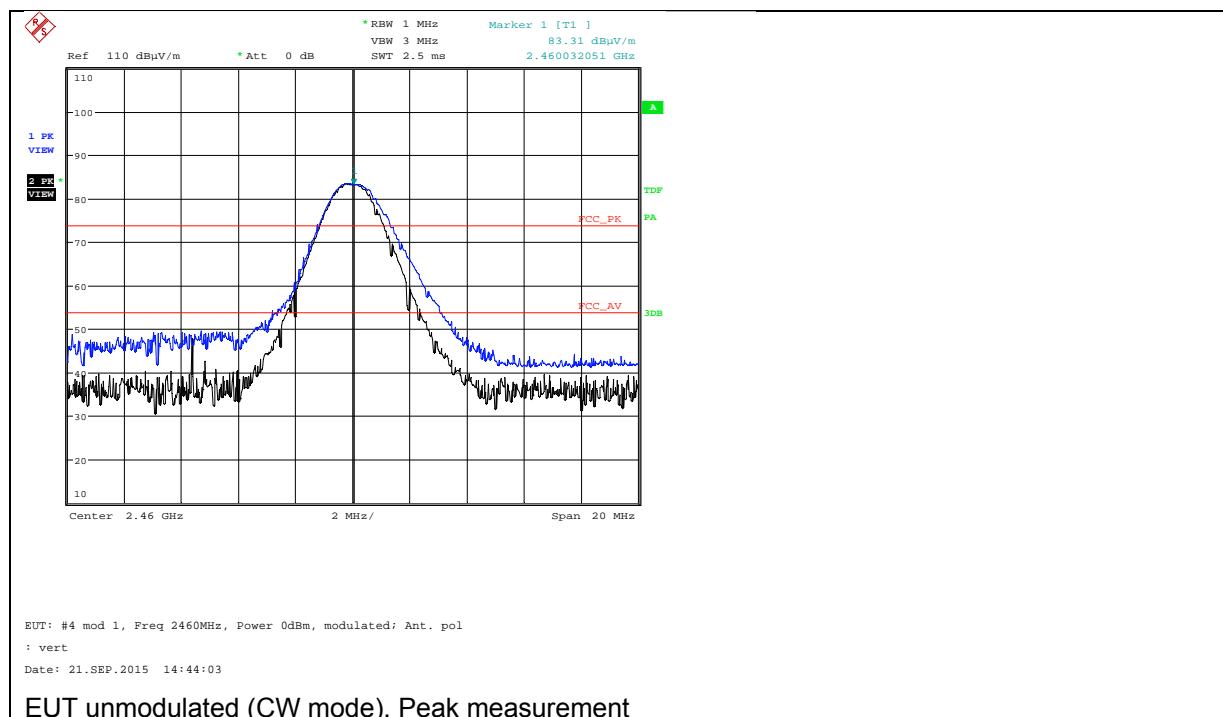
6.4 Calculation of Field Strength Limits

Fundamental field strength limits for the band 2400 – 2483.5 MHz:

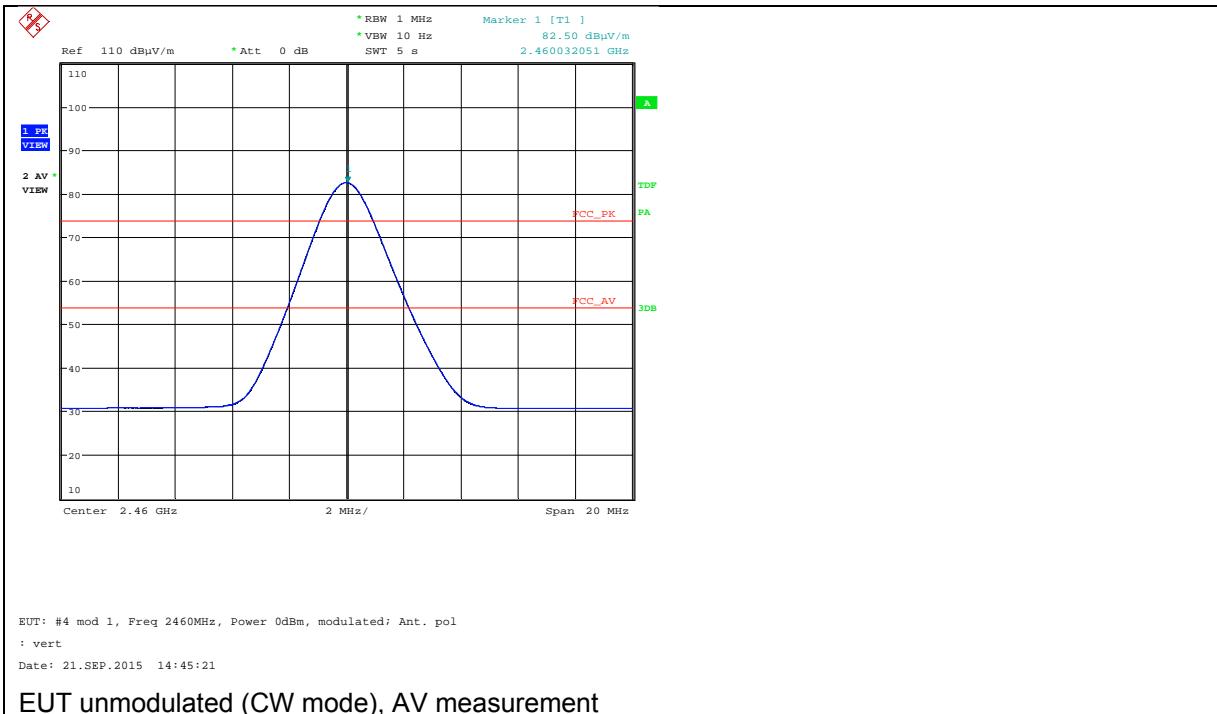
50 mV/m corresponds with 94 dB μ V/m.

6.5 Test Results

EUT mode	Frequency	Res/Video Bandwidth	Detector	Distance	Result	Limit	Margin
	GHz	Hz		m	dB μ V/m	dB μ V/m	dB
CW	2460	1 M / 3 M	Peak	3	83.3	114 Pk	30.7
CW	2460	1 M / 10	Peak	3	82.5	94 AV	11.5



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Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: Genius Motorbrake
Type: T2080 Genius
Serial Number: Sample #4, with modification 1

The EUT meets the requirements of this section.

Test Personnel: Ludwig Kraft
Test Date: 2015-09-21

7 RADIATED SPURIOUS EMISSIONS

Test Requirement: FCC 47 CFR, §15.249

Test Procedure: ANSI C63.4-2009

7.1 Regulation

§15.249

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental	Field strength of harmonics
	(millivolts/meter)	(microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

(c) Field strength limits are specified at a distance of 3 meters.

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

(e) As shown in § 15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

§15.209

(a) except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100	3
88–216	150	3
216–960	200	3
Above 960	500	3

(b) In the emission table above, the tighter limit applies at the band edges.

(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz Radiated emission limits in these three bands are based on measurements employing an average detector.

(e) The provisions in §§ 15.31, 15.33, and 15.35 for measuring emissions at distances other than the distances specified in the above table, determining the frequency range over which radiated emissions are to be measured, and limiting peak emissions apply to all devices operated under this part.

(f) In accordance with § 15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in § 15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in § 15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in § 15.109 that are applicable to the incorporated digital device.

§15.205 Restricted bands of operation.

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	(²)
13.36 - 13.41			

7.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
Spectrum Analyser	Rohde & Schwarz FSU	3831	2015-07	2016-07
Double Ridged Guide Ant.	Schwarzbeck BBHA 9120D	3235	2015-06	2017-06
EMI Test Receiver	Rohde & Schwarz ESS	303	2015-03	2016-03
Loop Antenna	Rohde & Schwarz	374	2014-06	2016-06
Biconilog. Antenna	EMCO 3143	898	2015-05	2017-05

7.3 Test Procedures

The EUT was tested on a 0.8 meter high support. For testing frequencies above 1 GHz the support height was 1.5 m for better alignment with the receive antenna.

With the EUT operating in a fixed transmitting frequency mode, emissions from the unit are maximized by adjusting the polarization and height of the receive antenna and rotating the EUT on the turntable. Manipulating the system cables also maximizes EUT emissions. All tests performed with the EUT placed on the nonconductive platform. Worst case emissions are listed under chapter: Test Results.

Radiated Emissions Test Characteristics	
Frequency range	9 kHz – 25 GHz
Test distance	3 m*
Test instrumentation resolution bandwidth	200 Hz (9 kHz – 150 kHz) 10 kHz (150 kHz - 30 MHz) 120 kHz (30 MHz - 1,000 MHz) 1 MHz (1,000 MHz – 25 GHz)
Test instrumentation video bandwidth	3 MHz (10 Hz**)
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Horizontal (H-field, f < 30 MHz) Vertical/Horizontal (E-field, f > 30 MHz)

* According to Section 15.31 (f)(1): At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. (...) When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements). According to Section 15.31 (f)(2) At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade).

H-field measurement up to 30 MHz was performed in a semi-anechoic room at a test distance of 3 m. A calibrated loop antenna as specified in ANSI C63.4 clause 4.1.5.1 was positioned with its plane vertical at the test distance from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. For certain applications, the loop antenna may also need to be positioned horizontally at the specified distance from the EUT. Instead of changing the loop antenna polarization to horizontal the EUT antenna was rotated by 90 degrees. I.e. tests performed for 2 EUT antenna polarizations. The center of the loop antenna was 1 m above the ground.

** Average measurement was performed with a 10 Hz video bandwidth.

7.4 Calculation of Field Strength Limits

The maximum permitted unwanted emission level – except for harmonics - is 50 dB below the maximum permitted fundamental level, i.e. 44 dB μ V/m or general radiated limits in §15.209 (54 dB μ V/m for frequencies above 960 MHz), whichever is lesser attenuation. For harmonics a limit of 500 μ V/m corresponding with 54 dB μ V/m applies. → Above 960 MHz the applicable limit for all emissions outside of the specified frequency band (2400 – 2483.5 MHz) is 54 dB μ V/m.

7.5 Calculation of Average Correction Factor

The average correction factor is computed by analyzing the "worst case" on time in any 100 mSec time period and using the formula:

$$\text{Corrections Factor (dB)} = 20 * \log (\text{worst case on time}/100 \text{ mSec})$$

Procedure during test:

The relationship between average and peak mode reading has been confirmed by direct measurement using video averaging for the fundamental frequency level measurement. The obtained by measurement correction factor (difference between peak measurement with VBW of 3 MHz and peak measurement with VBW of 10 Hz) for the fundamental level was used for calculation of the average reading of the spurious emission level. This calculation performed for peak results higher or close to the average limit, only. [N.A. CW peak results are below AV limit.]

7.6 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor. The basic equation with a sample calculation is as follows:

$$\text{FS} = \text{RA} + \text{AF} + \text{CF}$$

where

FS = Field Strength in dB μ V/m

RA = Receiver Amplitude in dB μ V

AF = Antenna Factor in dB(1/m)

CF = Cable Attenuation Factor in dB

Assume a receiver reading of 23.5 dB μ V is obtained. The Antenna Factor of 7.4 dB(1/m) and a Cable Factor of 1.1 dB are added, giving a field strength of 32 dB μ V/m. The 32 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

$$\text{FS} = 23.5 + 7.4 + 1.1 = 32 \text{ [dB}\mu\text{V/m]}$$

$$\text{Level in }\mu\text{V/m} = \text{Common Antilogarithm } (32/20) = 39.8$$

7.7 Test Results

9 kHz -30 MHz:

EUT Sample #3, mode standby and running

All emissions 20 dB below margin. For further details refer to the pre-scan test plots on following pages.

30 MHz-1000 MHz:

EUT Sample #3, mode standby and running, Sample #4 mode modulated

EUT mode	Frequency	RA	AF + CF	Result	Limit	Margin
	MHz	dB μ V	dB(1/m)	dB μ V/m	dB μ V/m	dB
run	41.91	28.8	10.3	39.1	40	0.9
run	39.0	27.4	11.2	38.6	40	1.4
run	288.01	26.8	17.6	44.4	46	1.6
run	30.0	18.3	14.5	32.8	40	7.2
run	122.62	14.1	9.4	23.6	43.5	19.9

The table above contains worst-case emissions only. For further details refer to the pre-scan test plots on following pages.

1 GHz – 25 GHz:

EUT: Sample #4, mode;CW, EUT frequency: 2460 MHz

EUT mode	Frequency	Result	Limit	Margin
	MHz	dB μ V/m	dB μ V/m	dB
CW	4920	47.5	54	6.5
CW	7380	44.7	54	9.3

The table above contains worst-case emissions only. For further details refer to the pre-scan test plots on following pages.

Measurement was performed in worst case operation mode.

Manufacturer: EBE Elektro-Bau-Elemente GmbH

Device: Genius Motorbrake

Type: T2080 Genius

Serial Number: Sample #3 (Radiated Emissions 150 kHz – 1 GHz, mode standby and running)
Sample #4, with modification 1 (Radiated Emissions 1 – 25 GHz, mode CW)

The EUT meets the requirements of this section.

Test Personnel: Ludwig Kraft

Test Date: 2015-07-20/21, 2015-09-17/21/25

7.7.1 Magnetic Field (f = 9 kHz to 30 MHz)

Sample #3, mode standby, prescan d = 3 m

EMCCons DR. RASEK

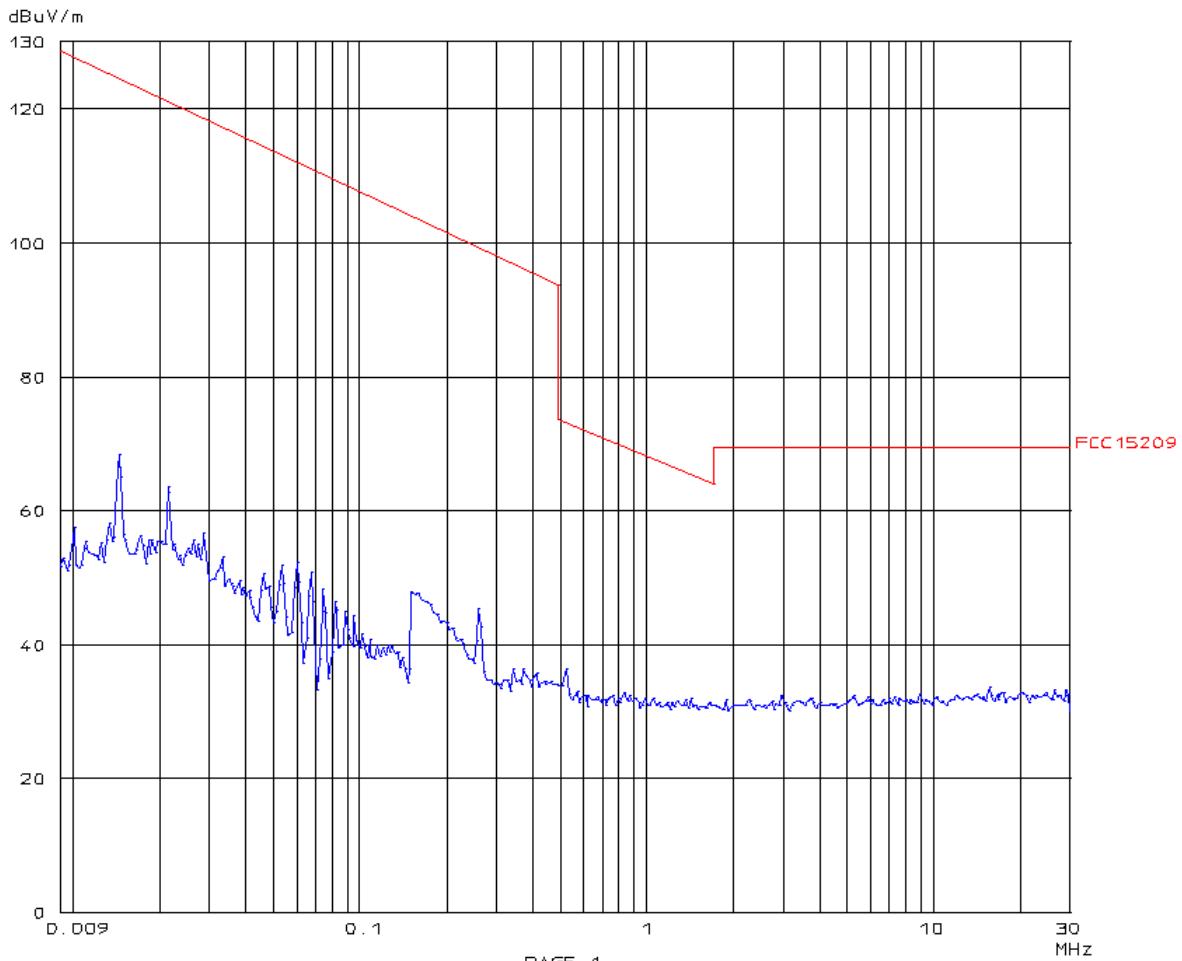
21. Jul 15 13:28

Radiated Emissions H Field in SAR, d=3m

EUT: #3
Manuf: EBE
Op Cond: standby
Operator: L. Kraft
Test Spec: FCC 15C
Comment: 4 directions. Ant 2 pol. EUT 2 dir

Scan Settings (Z Ranges)
|----- Frequencies -----| |----- Receiver Settings -----|
Start Stop Step IF BW Detector M-Time Atten Preamp OpRge
9k 150k 100Hz 200Hz PK 10ms AUTO LN DFF 60dB
150k 30M 5k 10k PK 5ms AUTO LD DFF 30dB

Final Measurement: x Hor-Max / + Vert-Max
Meas Time: 1 s
Subranges: 25
Acc Margin: 30dB



Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

Sample #3, mode running, prescan d = 3 m

EMCCons DR. RASEK

21. JUL 15 14:30

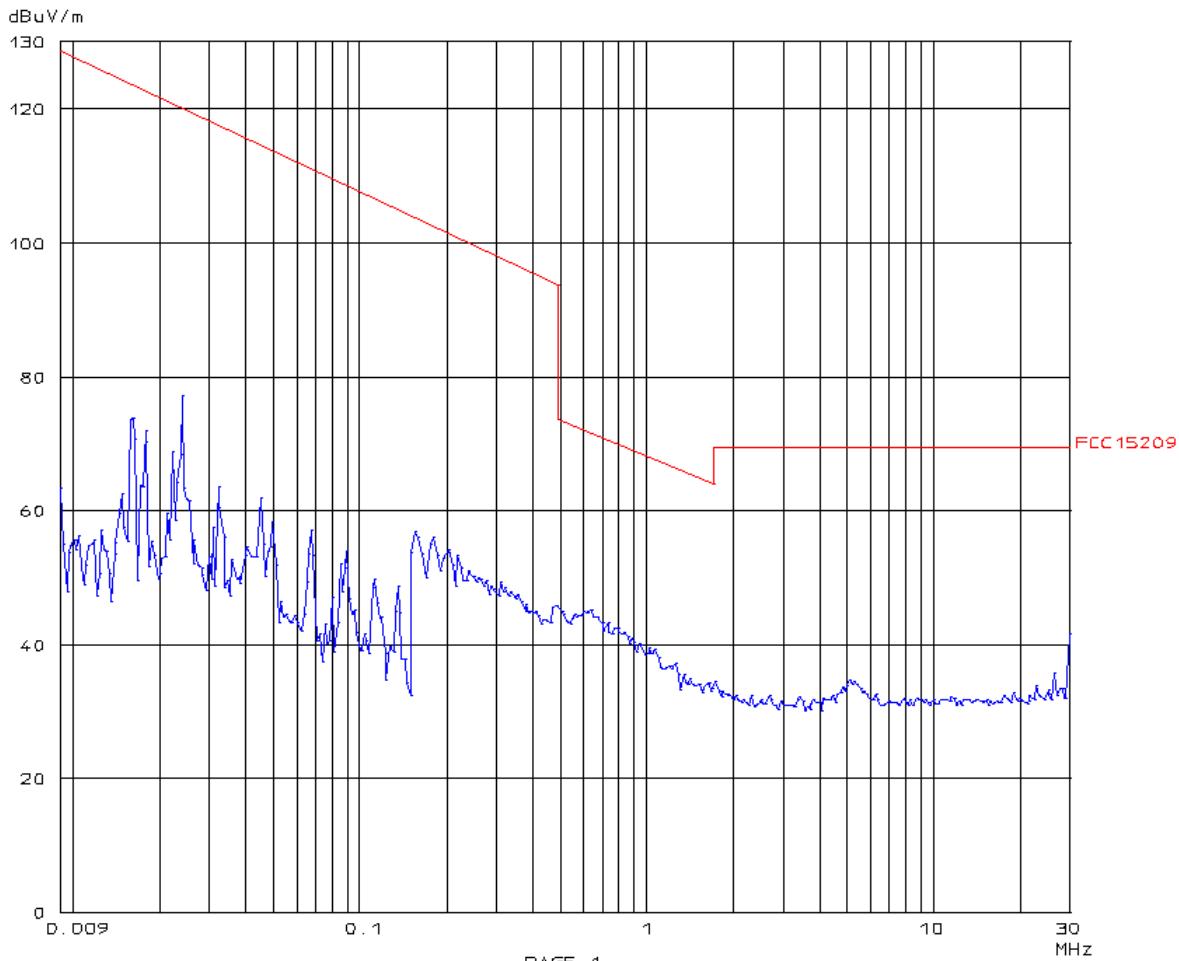
Radiated Emissions H Field in SAR, d=3m

EUT: #3
Manuf: EBE
Op Cond: running
Operator: L. Kraft
Test Spec: FCC 15C
Comment: 4 directions, Ant 2 pol. EUT axis hor

Scan Settings (Z Ranges)

Frequencies			Receiver Settings						
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge	
9K	150K	100Hz	200Hz	PK	10ms	AUTO	LN	DFF	60dB
150K	30M	5K	10K	PK	5ms	AUTO	LD	DFF	30dB

Final Measurement: x Hor-Max / + Vert-Max
Meas Time: 1 s
Subranges: 25
Acc Margin: 30dB



7.7.2 Electric Field (f = 30 MHz to 1 GHz)

Sample #3, mode standby, prescan d = 3 m

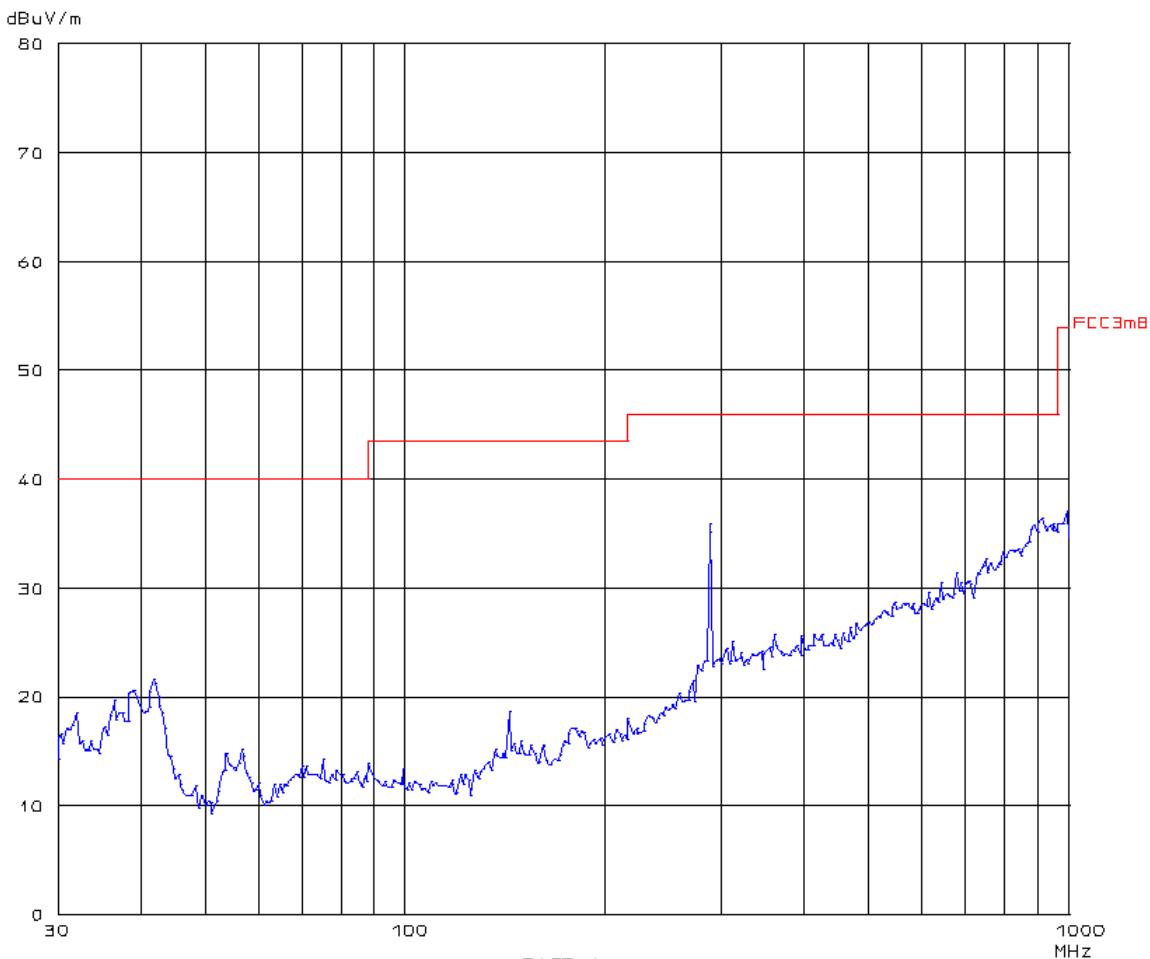
EMCC DR. RASEK

20. Jul 15 16:08

Radiated Emissions Prescan in SAR, d=3m

EUT: #3
Manuf: EBE
Op Cond: standby
Operator: L. Kraft
Test Spec: FCC 15
Comment: 4 directions, 3\4 heights

Fast Scan Settings (1 Range)
|----- Frequencies -----| |----- Receiver Settings -----|
Start Stop Step IF BW Detector M-Time Atten Preamp OpRge
30M 1000M 40k 120k PK 0.10ms 0dB LN ON 60dB
Transducer No. Start Stop Name
21 30M 1000M B9B26K33



Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

Sample #3, mode running, prescan d = 3 m

EMCC DR. RASEK

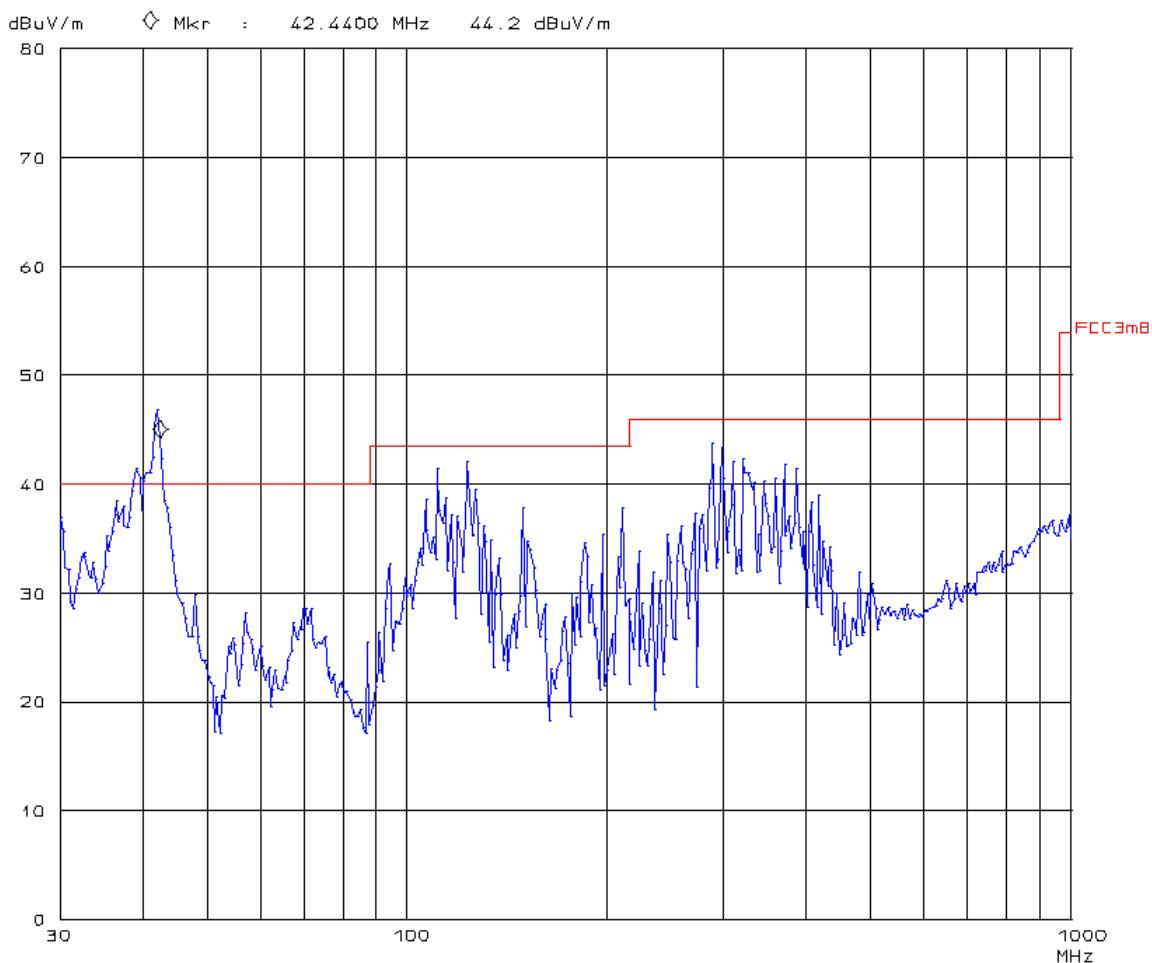
21. JUL 15 08:43

Radiated Emissions Prescan in SAR, d=3m

EUT: #3
Manuf: EBE
Op Cond: running
Operator: L. Kraft
Test Spec: FCC 15
Comment: 4 directions, 3x4 heights

Fast Scan Settings (1 Range)

Frequencies				Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
30M	1000M	40K	120K	PK	0.10ms	0dBBLN	ON	60dB
				Transducer	No.	Start	Stop	Name
				21	30M	1000M		89826K33



Prescan result, the final measurement was below the limit. See final measurement result above.

PAGE 1

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

Sample #4 modified, mode modulated, prescan d = 3 m

EMCC DR. RASEK

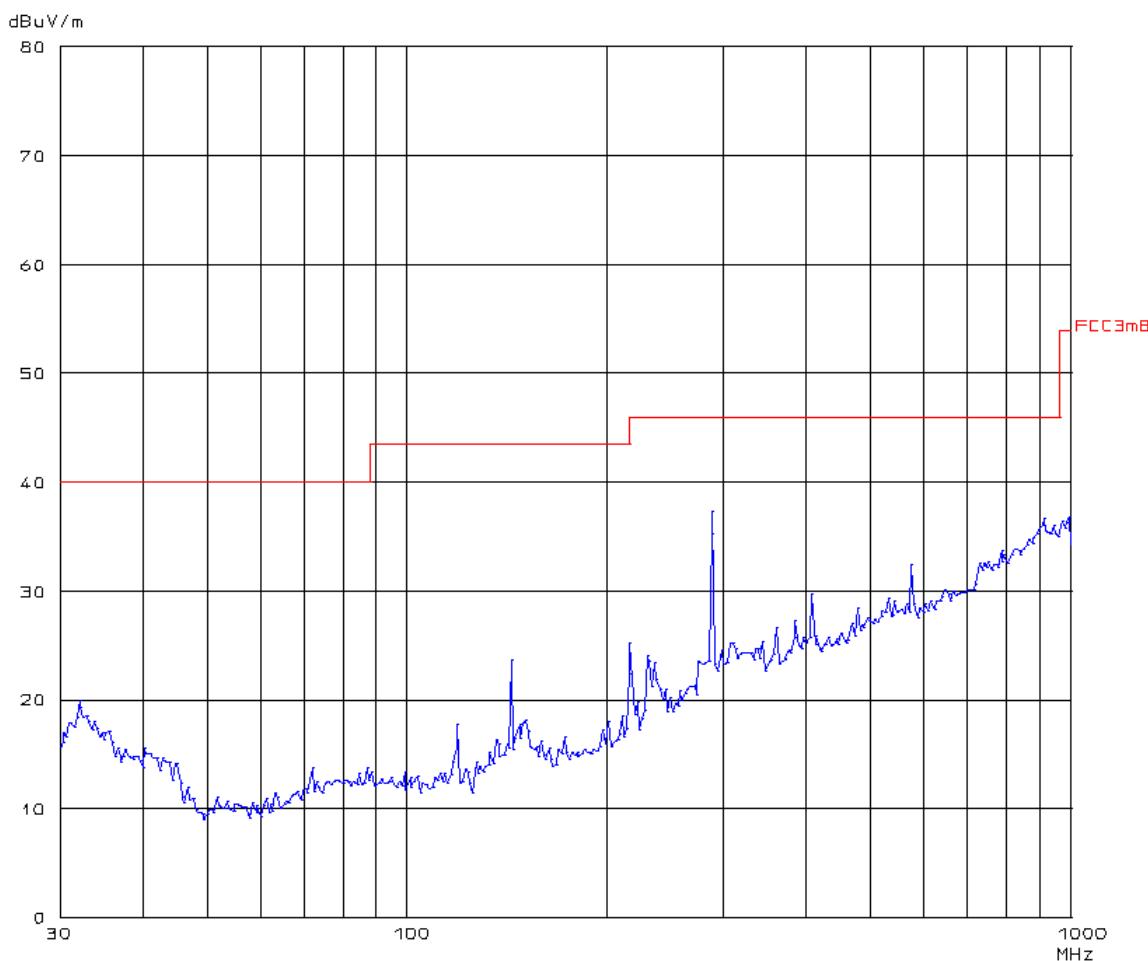
17. Sep 15 11:47

Radiated Emissions Prescan in SAR, d=3m

EUT: #4 (mod2)
Manuf: EBE
Op Cond: Freq 2440 MHz, Power 0dBm, modulated
Operator: L. Kraft
Test Spec: FCC 15
Comment: 4 directions, pol hor & ver, 3/4 heights

Fast Scan Settings (1 Range)

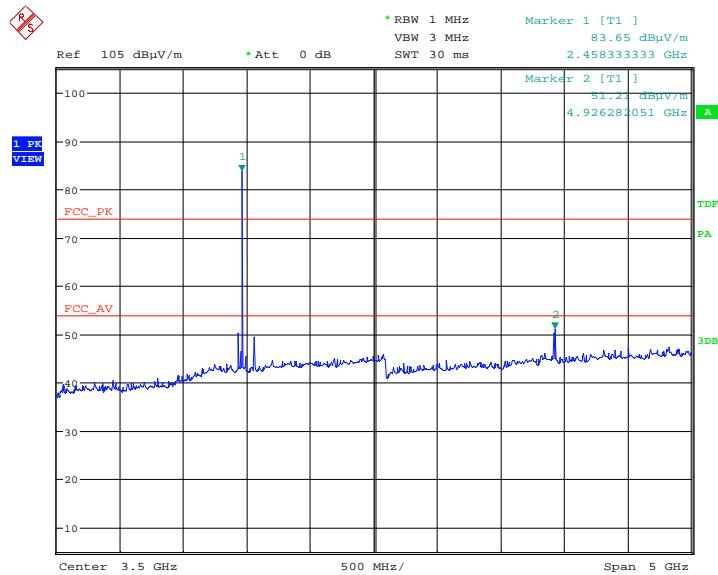
Frequencies				Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
30M	1000M	40K	120K	PK	0.10ms	0dBBLN	ON	60dB
				Transducer	No.	Start	Stop	Name
				21	30M	1000M		89826K33



Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

7.7.3 Electric Field (f = 1 GHz to 25 GHz)

Sample #4 with modification 1, plots CW mode

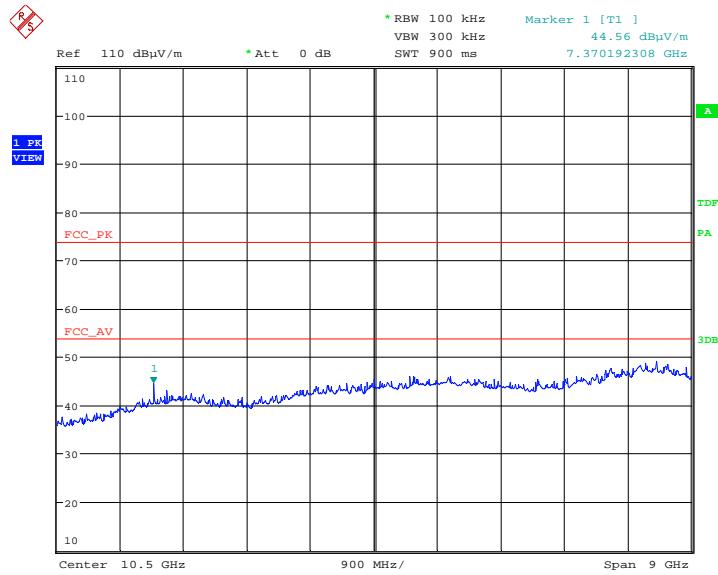


EUT: #4 mod 1, Freq 2460MHz, Power 0dBm, modulated; Ant. pol

: vert

Date: 21.SEP.2015 12:46:26

Prescan 1 – 6 GHz, antenna pol. vert.; d = 3 m



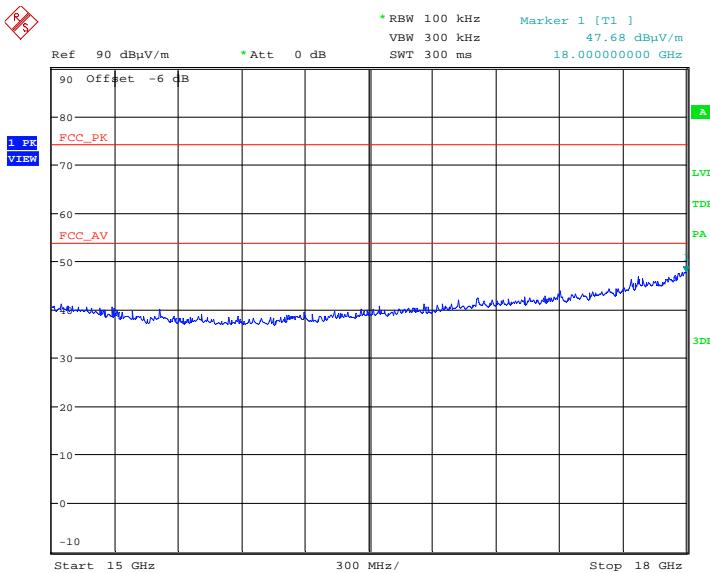
EUT: #4 mod 1, Freq 2460MHz, Power 0dBm, modulated; Ant. pol

: vert

Date: 21.SEP.2015 18:14:45

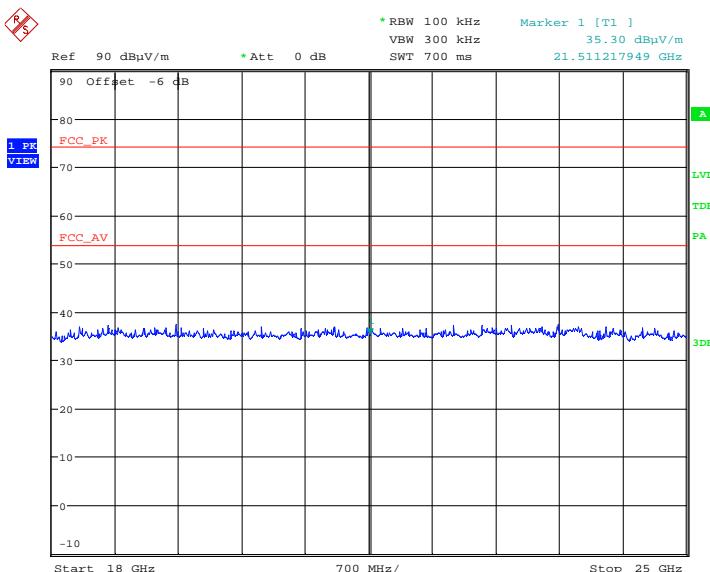
Prescan 6 – 15 GHz, antenna pol. vert.; d = 3 m

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C



EUT: #4 mod, Freq 2460MHz, Power 0dBm, modulated; Ant. pol: vert
Date: 25.SEP.2015 14:54:03

Prescan 15 – 18 GHz, antenna pol. vert.; RBW 100 kHz, d = 1.5 m (dist. corr. factor 6dB included as offset)



EUT: #4 mod, Freq 2440MHz, Power 0dBm, modulated; Ant. pol: vert
Date: 25.SEP.2015 16:22:33

Prescan 18 – 25 GHz, antenna pol. vert.; RBW 100 kHz, d = 1.5 m (dist. corr. factor 6dB included as offset)

8 BAND-EDGE EMISSIONS

Test Requirement: FCC §15.249

Test Procedure: ANSI C63.10 – 2009 §6.9.2

8.1 Regulation

§15.249

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

8.2 Test Equipment

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
Spectrum Analyser	Rohde & Schwarz FSU	3831	2015-07	2016-07
Double Ridged Guide Ant.	Schwarzbeck BBHA 9120D	3235	2015-06	2017-06

8.3 Test Procedure

Connect the spectrum analyzer to the EUT using an appropriate RF cable connected to the EUT output. Configure the spectrum analyzer settings as described below (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).

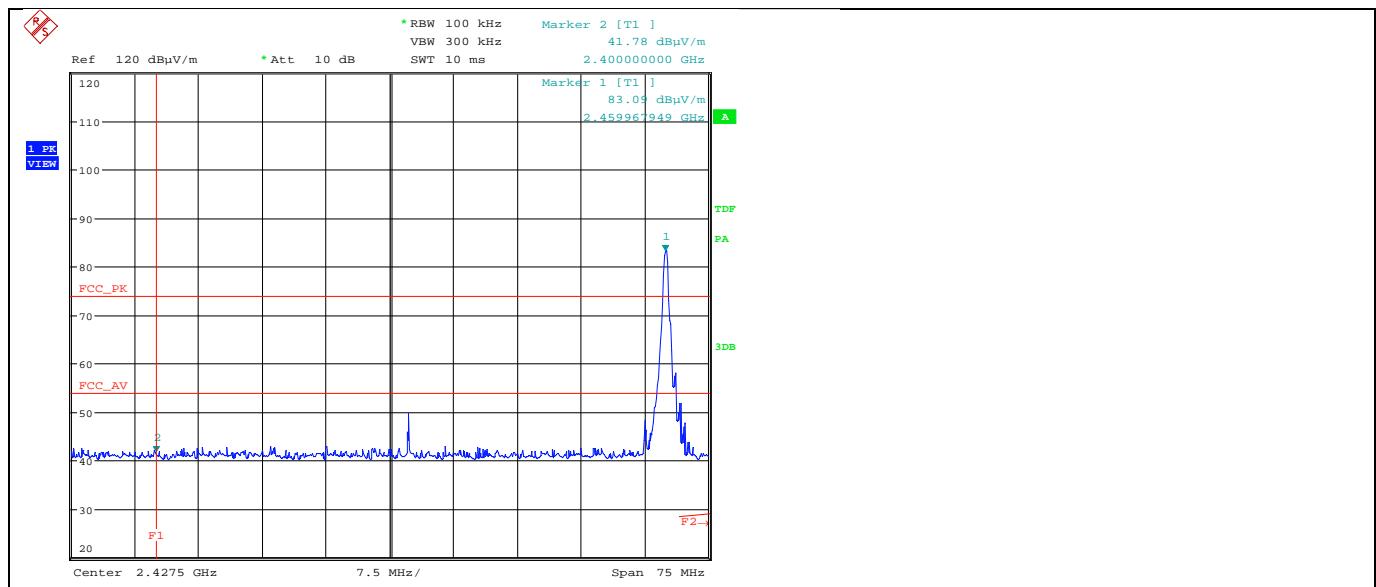
- Span: Set Span for minimum 50 MHz
- Reference Level: 120 dB μ V (corrected for gains and losses of test antenna factor, preamp gain and cable loss)
- Attenuation: 10 dB
- Sweep Time: Coupled
- Resolution Bandwidth: 100 kHz
- Video Bandwidth: Below 300 kHz
- Detector: Peak

Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot.

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

8.4 Test Results

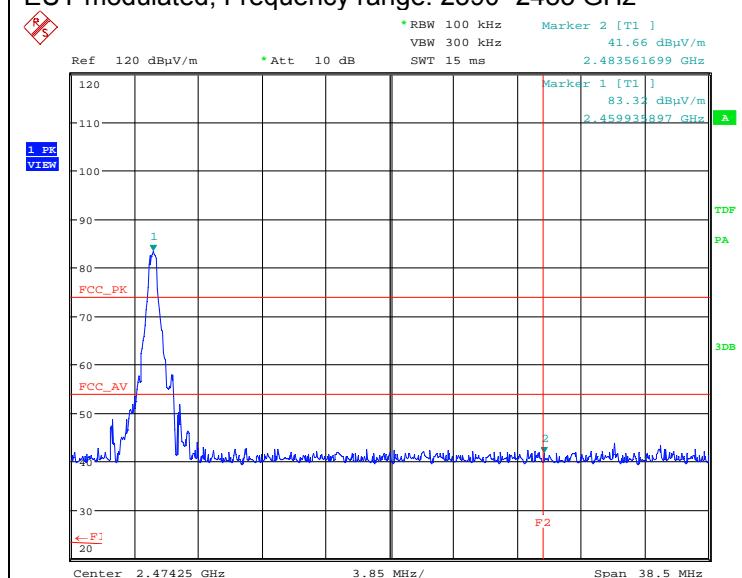
Frequency	Reading	Limit	Margin
MHz	dB μ V/m	dB μ V/m	dB
2400	41.8	54.0	12.1
2483.5	41.7	54.0	12.3



EUT: #4 mod 1, Freq 2460MHz, Power 0dBm, modulated

Date: 19.OCT.2015 16:48:27

EUT modulated, Frequency range: 2390 -2485 GHz



EUT: #4 mod 1, Freq 2460MHz, Power 0dBm, modulated

Date: 19.OCT.2015 16:50:14

EUT modulated, Frequency range: 2455 -2493.5 GHz

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: Genius Motorbrake
Type: T2080 Genius
Serial Number: Sample #4 with modification 1

The EUT meets the requirements of this section.

Test Personnel: Ludwig Kraft
Test Date: 2015-09-28

9 EMISSION BANDWIDTH

Test Requirement: FCC §15.215

Test Procedure: ANSI C63.10 – 2009 §6.9.1

9.1 Regulation

§15.215

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	Rohde & Schwarz FSU	3831	2015-07	2016-07
Double Ridged Guide Ant.	Schwarzbeck BBHA 9120D	3235	2015-06	2017-06

9.2 Test Procedures

Test Procedure: ANSI C63.10 – 2009 §6.9.1

The following procedure shall be used for measuring OBW of the fundamental frequencies of certain unlicensed wireless devices, when required.

A spectrum analyzer or other instrument providing a spectral display is recommended for these measurements. When using a spectrum analyzer or other instrument providing a spectral display the video bandwidth shall be set to a value at least three times greater than the IF bandwidth of the measuring instrument to avoid the introduction of amplitude smoothing. Video filtering is not used during occupied bandwidth tests.

- The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the unlicensed wireless device at either the fundamental frequency or the first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. Once the reference level is established, the equipment is conditioned with typical modulating signals to produce the worst-case (i.e., the widest) bandwidth. Unless otherwise specified for an unlicensed wireless device, measure the bandwidth at the –20 dB levels with respect to the reference level.
- To measure the modulated signal properly, a resolution bandwidth that is small compared with the bandwidth required by the procuring or regulatory agency shall be used on the measuring instrument.

- The span range for the SA display shall be between two times and five times the OBW.
- The nominal IF filter bandwidth (3 dB RBW) should be approximately 1 % to 5 % of the OBW, unless otherwise specified, depending on the applicable requirement.
- The dynamic range of the SA at the selected RBW shall be more than 10 dB below the target “dB down” (attenuation) requirement, i.e., if the requirement calls for measuring the –20 dB OBW, the SA noise floor at the selected RBW shall be at least 30 dB below the largest measured value on the display

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

c) Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. Turn the EUT on, and set it to a frequency within its operating range and within regulatory requirements. Set a reference level on the measuring instrument at any level that will allow measuring the specified bandwidth (e.g., –20 dB below the unmodulated carrier).

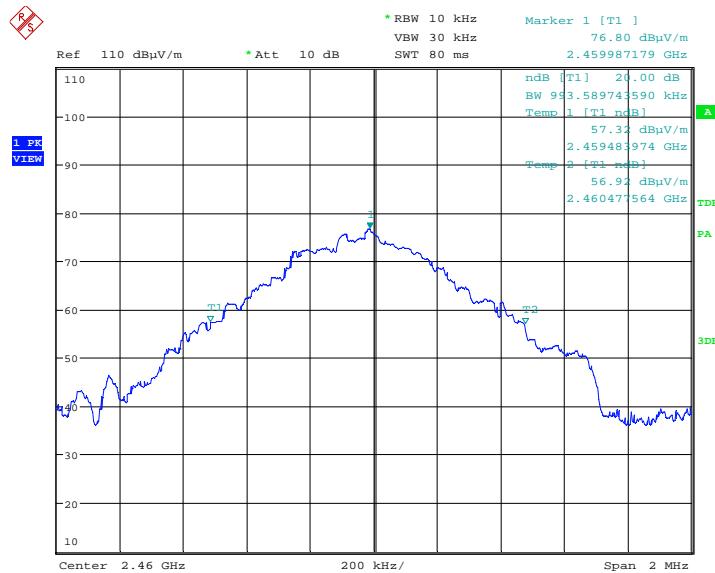
d) Supply the EUT with modulation. Devices modulated from internal sources shall be tested with typical modulation applied. If a device is equipped with input connectors for external modulation, typical modulating signals shall be applied at the maximum-rated input level for the device. Observe and record with plotted graphs or photographs the worst-case (i.e., widest) occupied bandwidth produced by these different modulation sources.

e) Set a reference level on the measuring instrument equal to the highest amplitude signal observed from the unlicensed wireless device at either the fundamental frequency or the first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.

f) Measure the frequencies of the modulated signal from the EUT, where it is the specified number of decibels below the reference level. The result is the occupied bandwidth.

9.3 Test Results

Frequency [MHz]	20 dB Bandwidth [kHz]
2460	994



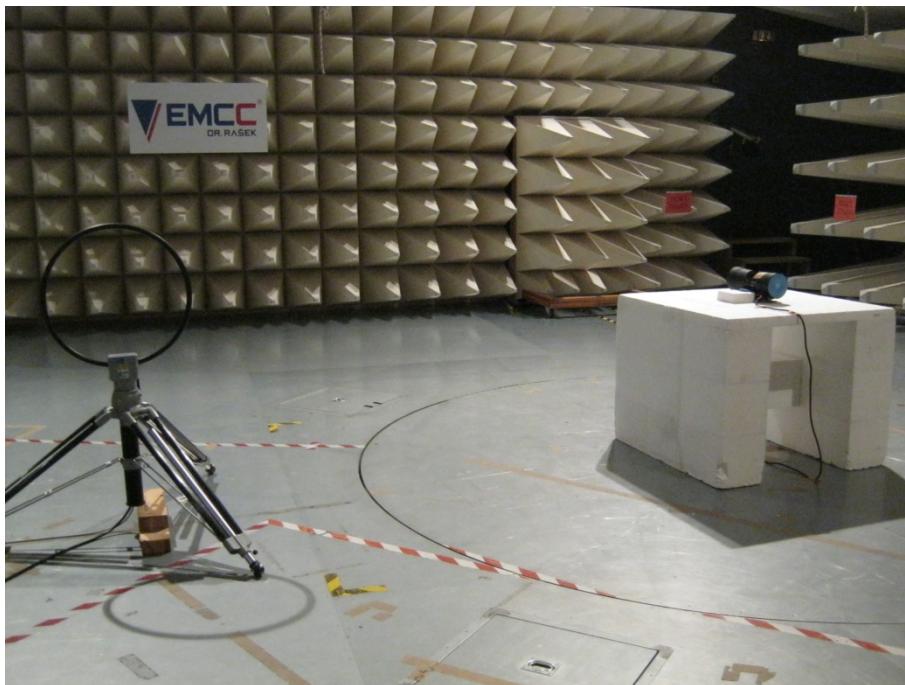
EUT: #4 mod 1, Freq 2460MHz, Power 0dBm, modulated; Ant. pol : vert
Date: 23.OCT.2015 16:58:00

Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: Genius Motorbrake
Type: T2080 Genius
Serial Number: Sample #4

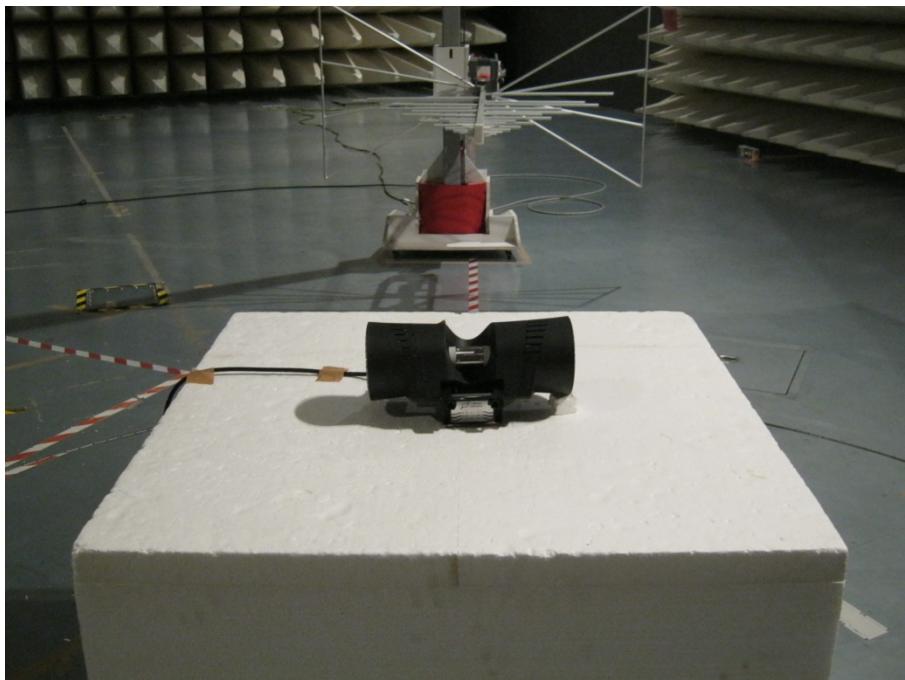
The EUT meets the requirements of this section.

Test Personnel: Ludwig Kraft
Test Date: 2015-10-23

APPENDIX 1 - PHOTOGRAPHS OF TEST SETUP

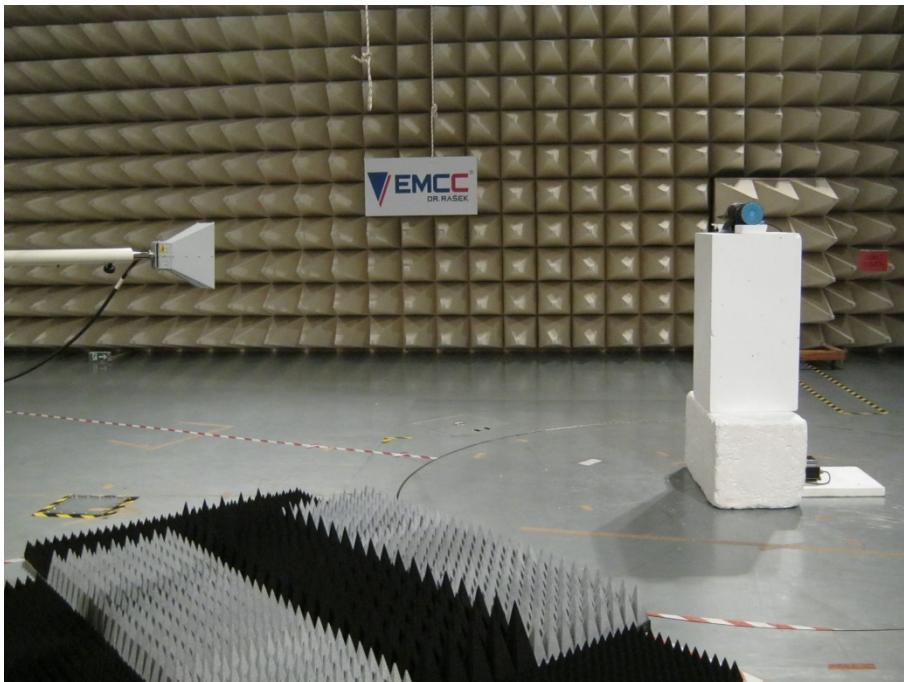


Photograph A1-1: H-Field measurement

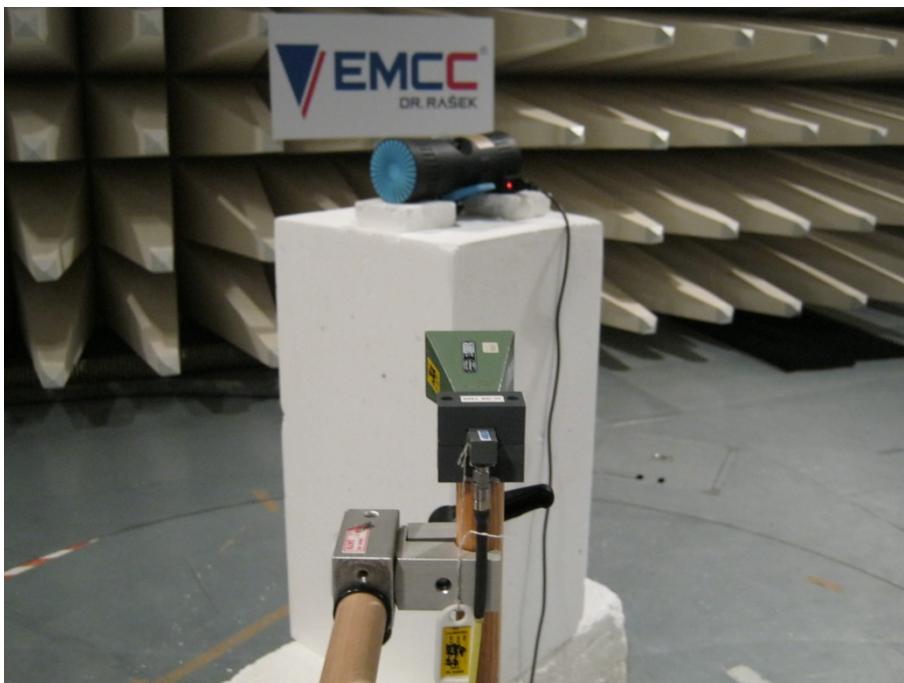


Photograph A1-2: Pre-scan measurement below 1 GHz (SAC)

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

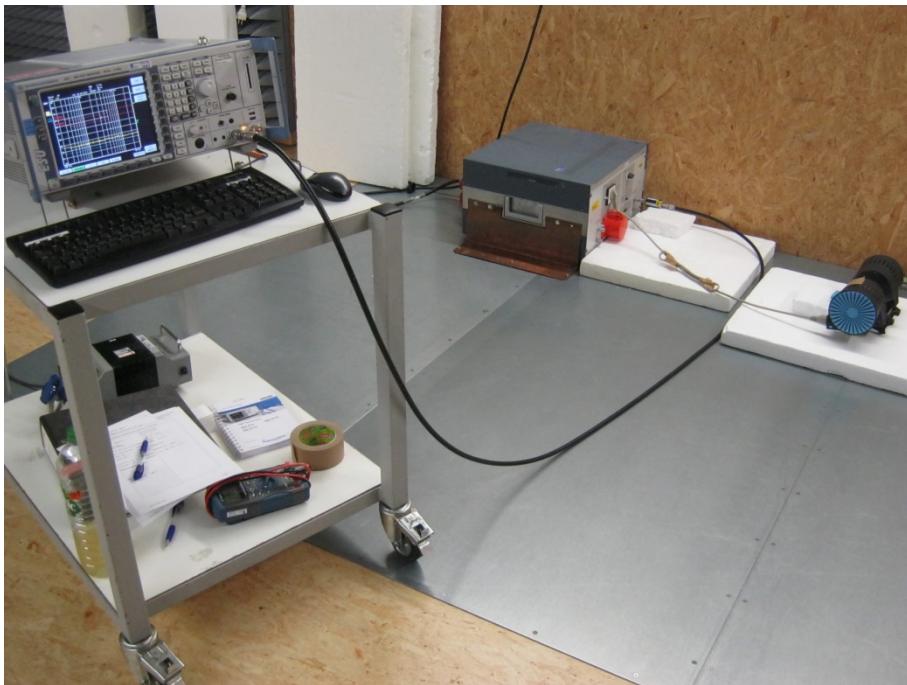


Photograph A1-3: Carrier measurement (SAC), spurious measurement 1 – 18 GHz



Photograph A1-4: Measurement above 18 GHz (SAC)

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C



Photograph A1-5: Conducted Emission Measurement

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

APPENDIX 2 - PHOTOGRAPHS OF EUT; EXTERNAL VIEW



Photograph A2-1: Top view Sample #3

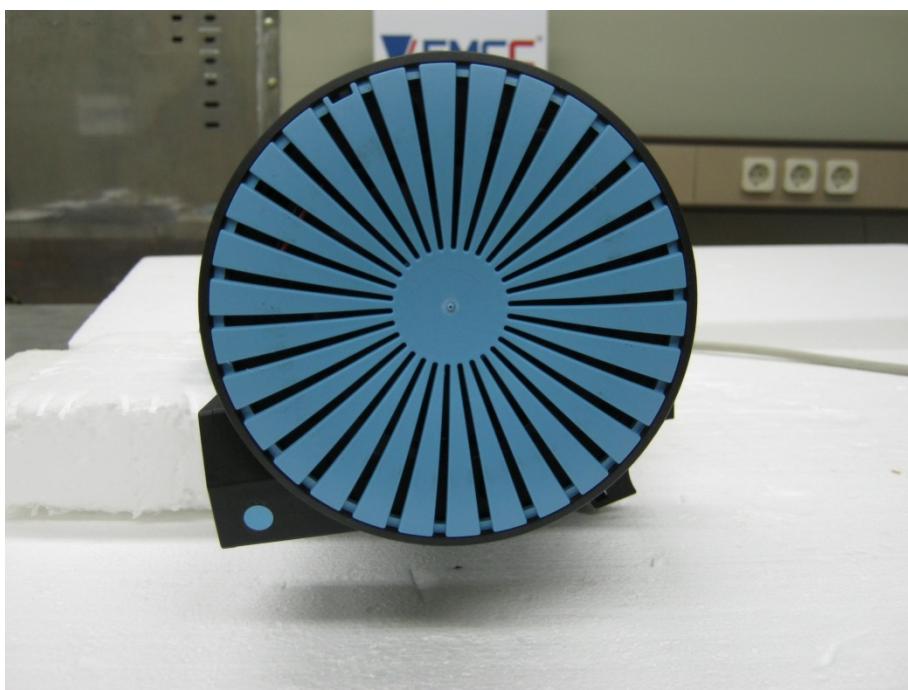


Photograph A2-2: Bottom view Sample #3

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C

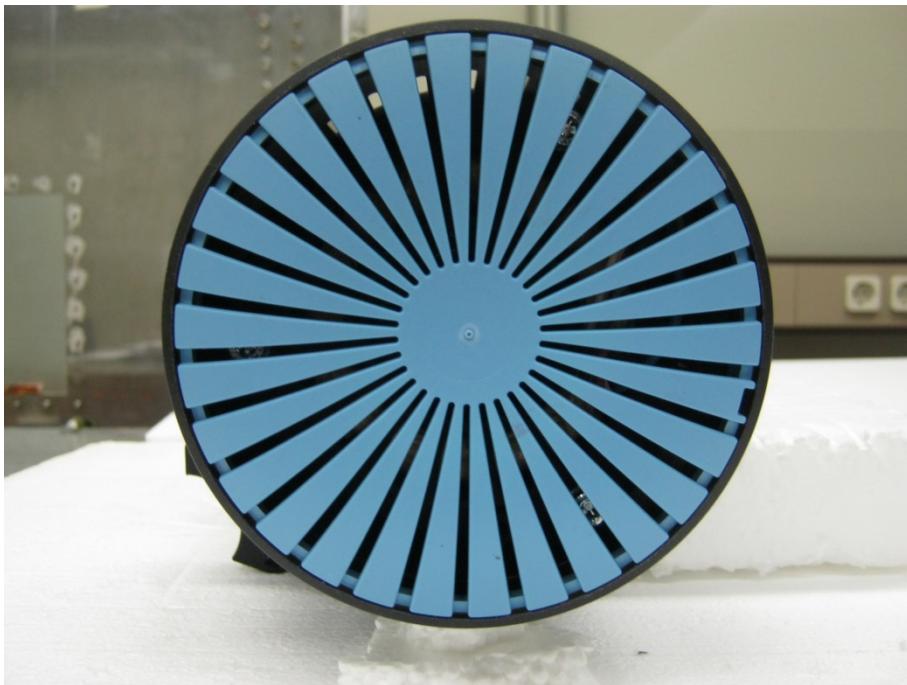


Photograph A2-3: Detail EUT label Sample #3



Photograph A2-4: Right side view Sample #3

Radio Tests on Genius Motorbrake Type T2080 Genius to 47 CFR Part 15C



Photograph A2-5: Left side view Sample #3



Photograph A2-6: Back side view Sample #4

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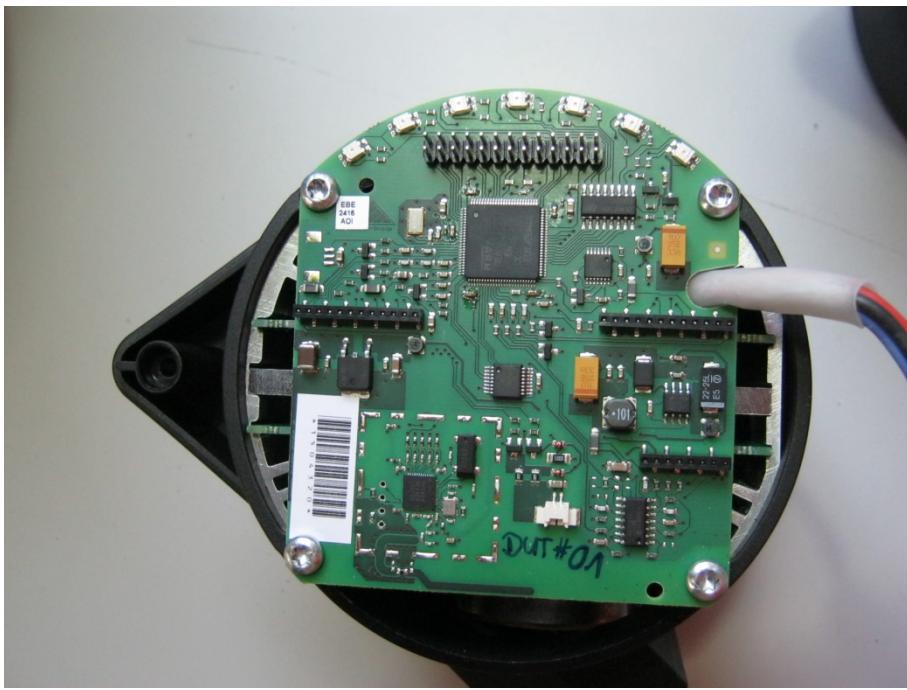


Photograph A2-7: Top side view Sample #4 with connection cable

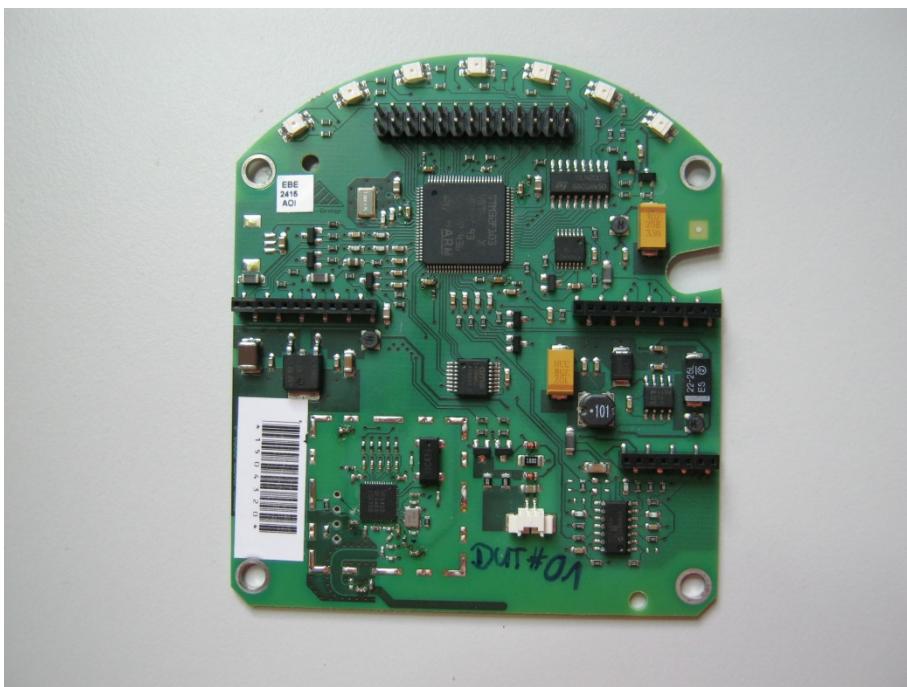


Photograph A2-8: Detail view Sample #4, housing opened for connection to terminal

APPENDIX 3 - PHOTOGRAPHS OF EUT; INTERNAL VIEW



Photograph A3-1: Internal view – Transceiver board without modification, Top view



Photograph A3-2: Internal view – Transceiver board with modification, Top view

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Photograph A3-3: Internal view, right side, plastic cover removed



Photograph A3-4: Internal view, left side, plastic cover removed