TEST REPORT # EMCC-011166BAA 2013-05-17

EQUIPMENT UNDER TEST:

Trade Name:	iGenius
Component:	Motorbrake
Type:	T2021
Serial No:	5137
Equipment Category:	Short Range Equipment
Application:	Motorbrake with Wireless Data Transfer
Manufacturer:	EBE Elektro-Bau-Elemente GmbH
Address:	Harthäuser Straße 4 70771 Leinfelden-Echterdingen Germany
Applicant:	EBE Elektro-Bau-Elemente GmbH
Contact Person:	Mr Osama Dengler
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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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TEST PERSONNEL:

Manuel Zenk

HEAD OF LABORATORY:

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Reinhard Sauerschell

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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 Manuel Zenk
Phone:	+49 9194 9016
Fax:	+49 9194 8125
E-Mail:	m.zenk@emcc.de
Web:	www.emcc.de

1.4 Manufacturer

Company Name:	EBE Elektro-Bau-Elemente GmbH
Street:	Harthäuser Straße 4
City:	70771 Leinfelden-Echterdingen
Country:	Germany

1.5 Applicant

Company Name:	EBE Elektro-Bau-Elemente GmbH
Street:	Harthäuser Straße 4
City:	70771 Leinfelden-Echterdingen
Country:	Germany
Name for contact purposes:	Mr Osama Dengler
Phone:	+49 711 79986-222
E-mail	osama.dengler@ebe-gmbh.de

1.6 Dates

Date of receipt of EUT:	CW 08/2013 (finally modified EUT, see chapter 2.5 for modification)
Test Date:	see table below

1.7 Ordering Information

Purchase Order and Date:	156162, dated 2012-09-12
Vendor Number:	209576

1.8 Climatic Conditions

Date	Temperature [°C]	Relative Humidity [%]	Air Pressure [hPa]	Lab	Customer attended tests
2013-02-18	22	32	977	IV	no
2013-02-19	22	32	974	IV	no
2013-02-20	22	37	973	IV	no
2013-02-22	22	30	971	IV	no
2013-03-06	22	29	965	IV	no

2 PRODUCT DESCRIPTION

2.1 Equipment Under Test (EUT)

Trade name:	iGenius
Component:	Motorbrake
Type:	T2021
Serial No.:	5137
Application:	Motorbrake with Wireless Data Transfer
Power:	
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 iGenius Motorbrake is part of the iGenius VR Trainer system.

The iGenius Motorbrake is linked via ANT protocol with the control PC running the VR trainer 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 USB2 Stick (supplied by the manufacturer)
- Laptop PC (EMCC ID #3454)
- Application software (Genius Test Application supplied by manufacturer)

Photograph 2.3-1: Laptop PC with application software and ANT USB2 Stick

Photograph 2.3-2: ANT USB2 Stick plugged into Laptop PC

2.4 Mode of Operation during Testing

The EUT test modes were 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 EUT was operated in a special CW test mode and in modulated test mode with random data, respectively.

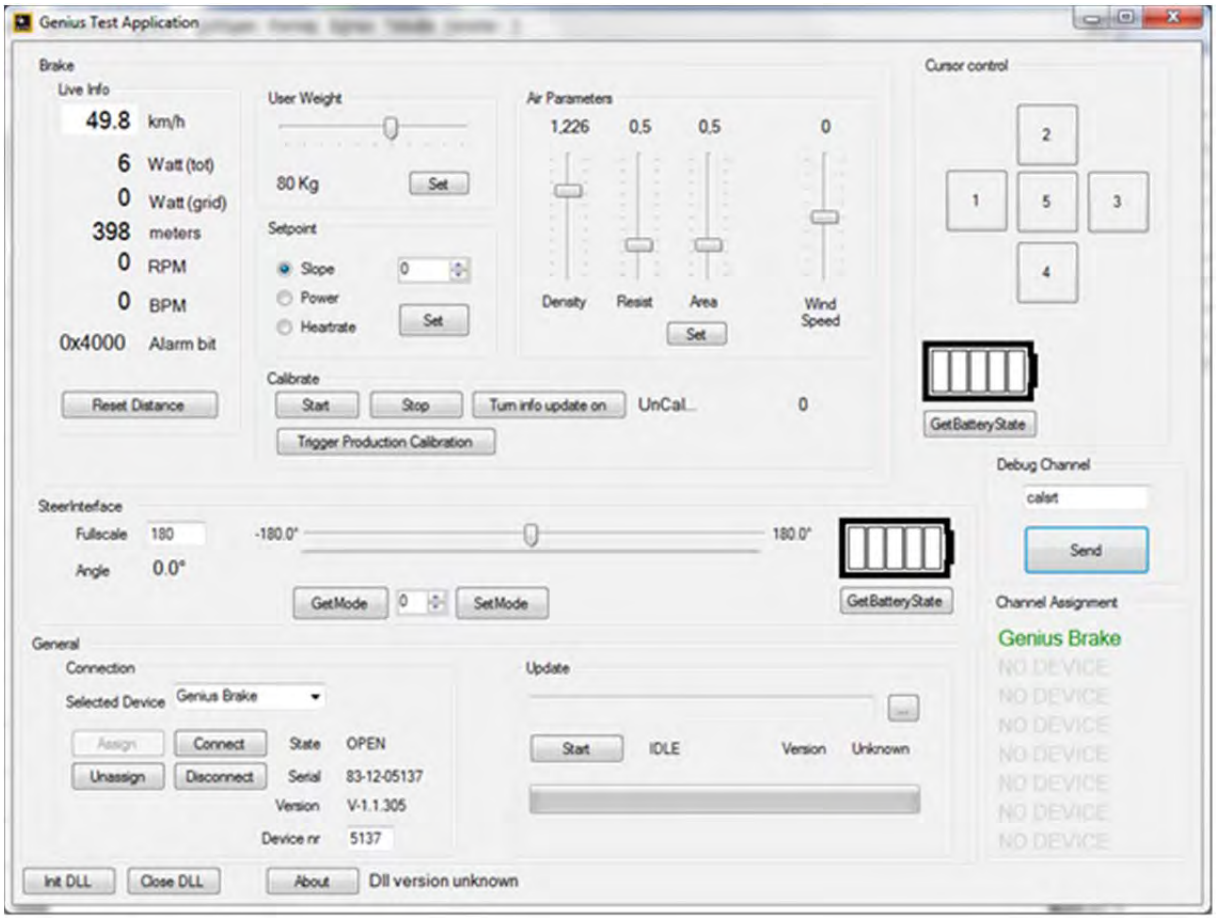
For further details refer to the following description as received from the manufacturer.

Power line conducted emissions were tested in standby and running of the motorbrake.

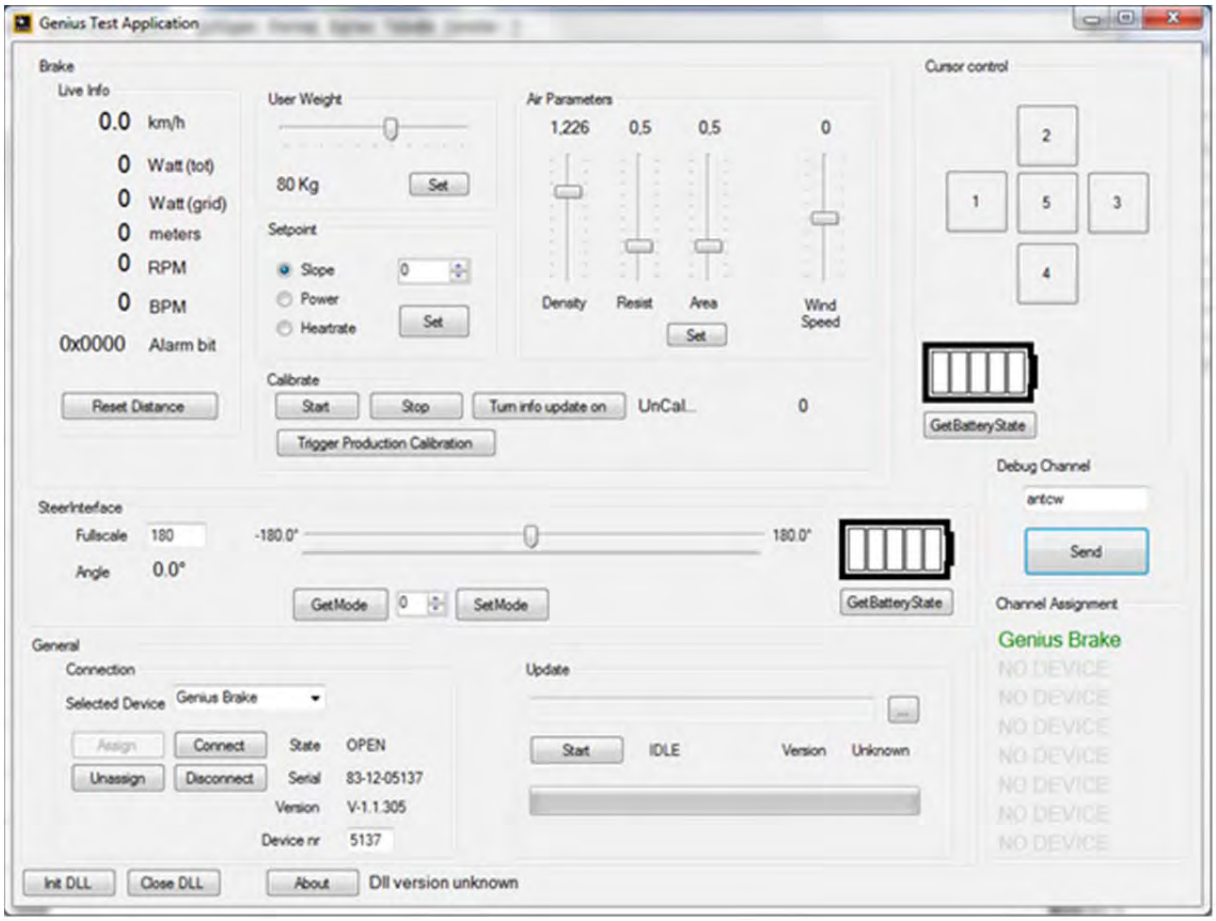
Brake

1 „Standby“: Betriebszustand: "Standby" (nur Netzumrichter aktiv - automatisch ca. 10s nach dem Einschalten)

2 „Motor running“: Betriebszustand: Motor dreht (entsprechend 50km/h Bergabfahrt - Befehle: contest u. calsrt)



3 CW mode: über "Debug Channel" in der Genius Test Application folgendes Kommando an die Bremse senden: Für Aussendung des unmodulierten Trägers auf 2460 MHz: antcw



Modulated mode: über "Debug Channel" in der Genius Test Application folgendes Kommando an die Bremse senden: Für Aussendung zufälliger Datenpakete (ansonsten wie Normalbetrieb): antrnd

2.5 Modifications required for Compliance

In order to meet the conducted emissions requirements modifications were applied in CW08/2013 (2013-02-21) by the manufacturer:
“Mains inverter choke (part L11 acc. to circuit diagram from Nov. 11, 2012) was covered with copper foil to improve electrostatic shielding.”
EUT photographs as contained in Appendix 2 and 3 of this report were taken of the modified EUT.
For detailed information on the applied modifications please refer to the manufacturer’s recordings.

3 TEST RESULTS SUMMARY

Summary of test results for the following EUT:

Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: iGenius Motorbrake
Type: T2021
Serial Number: 5137

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

N.A. – Not applicable. The EUT is battery powered, only.

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: Manuel Zenk
Issuance Date: 2013-05-17

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 Part 15C. The manufacturer may design the unit so that the user can replace a broken antenna, 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 Sections 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 Section 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.

According to DA 00-2225 "OET Extends Effective Date of Antenna Connector Requirement Indefinitely", dated September 28, 2000, the OET extends the effective date of Public Notice, DA 00-1087, indefinitely.

4.2 Result

Manufacturer:	EBE Elektro-Bau-Elemente GmbH
Device:	iGenius Motorbrake
Type:	T2021
Serial Number:	5137

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

Section 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 µH/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.

Section 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	2012-05	2013-05
V-LISN 50 ohms//(50 uH + 5 ohms)	Rohde & Schwarz ESH2-Z5	1901	2011-10	2013-10
AC Power Source	Elgar, SW5250M, SW5250S, SW PDU, SW Input Filter	33	N.A.	N.A.
Multimeter	Agilent U1241B True RMS	3662	2011-03	2013-03

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 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

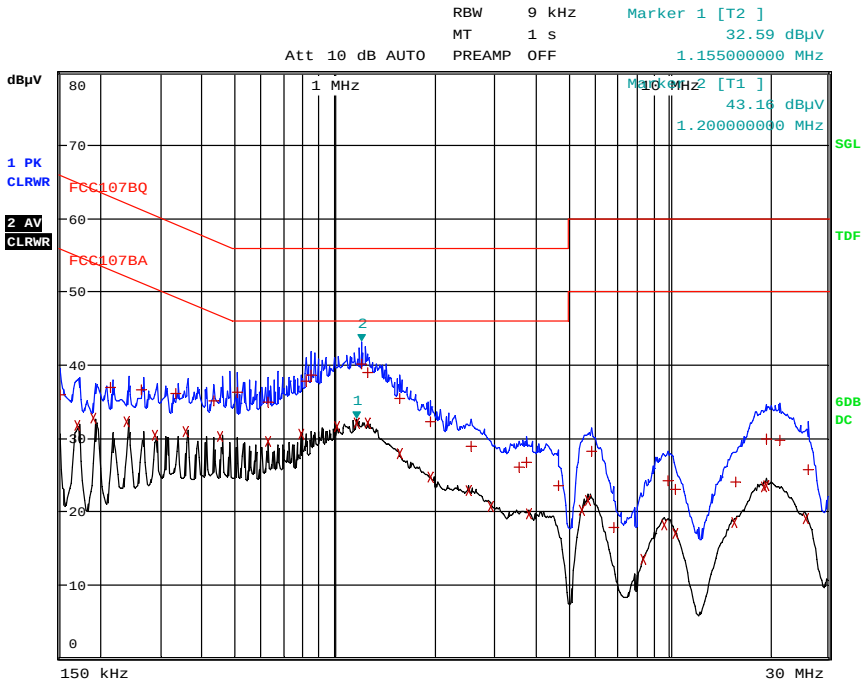
Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: iGenius Motorbrake
Type: T2021
Serial Number: 5137 (measurement was performed after modification as per chapter 2.5)

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

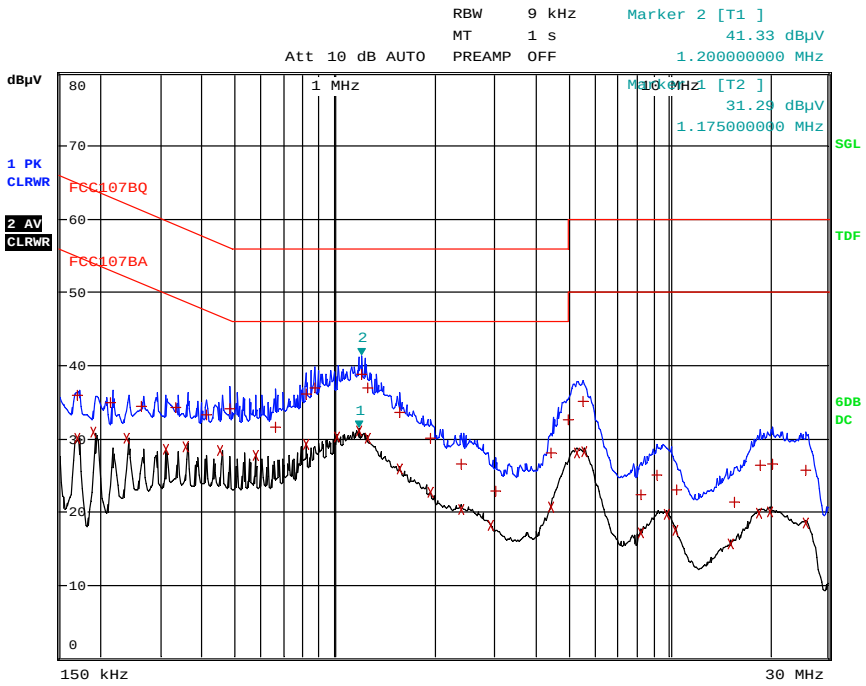
Test Personnel: Manuel Zenk
Test Date: 2013-02-22

5.5 Measurement Plots

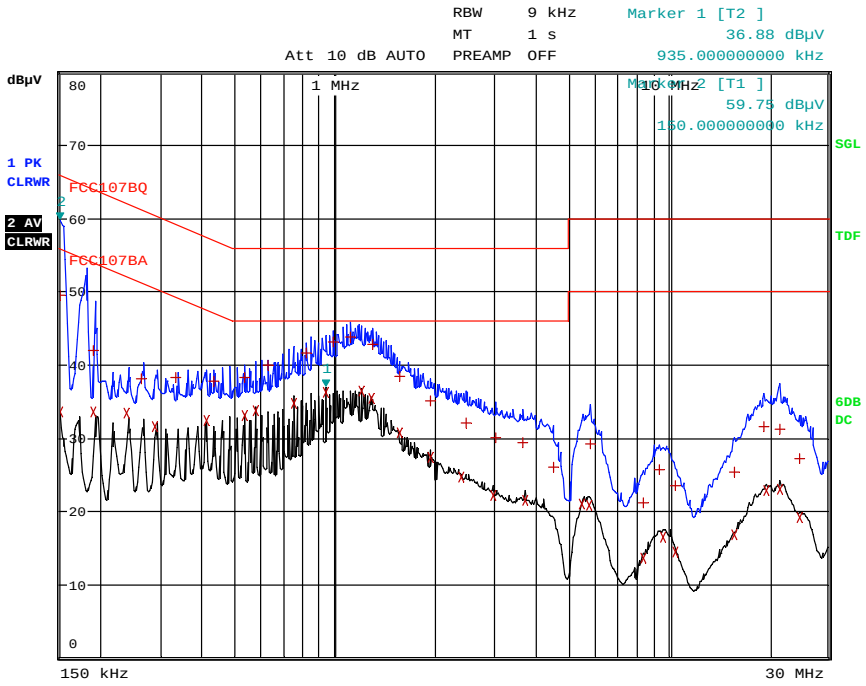
Refer to following pages.



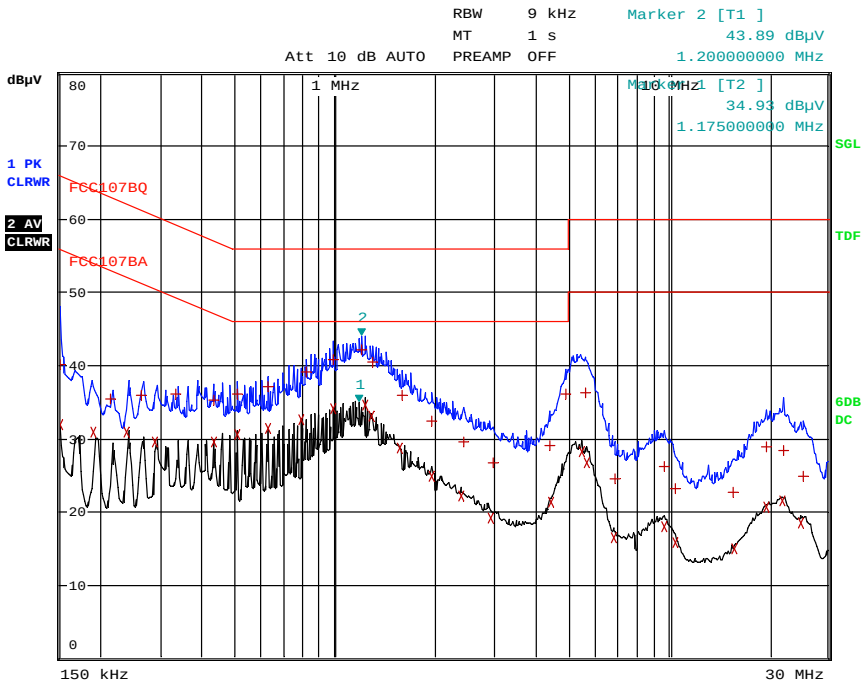
GENIUS Brake 5137, standby, 115V / 60 Hz, N
Date: 22.FEB.2013 16:23:52



GENIUS Brake 5137, standby, 115V / 60 Hz, L
Date: 22.FEB.2013 16:28:55



GENIUS Brake 5137, running, 115V / 60 Hz, N
Date: 22.FEB.2013 16:39:54



GENIUS Brake 5137, running, 115V / 60 Hz, L
Date: 22.FEB.2013 16:34:18

6 FIELD STRENGTH LIMITS (FUNDAMENTAL)

Test Requirement: FCC 47 CFR, Part 15 §249
Test Procedure: ANSI C63.4-2009

6.1 Regulation

§ 15.249 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz.
(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**
EMI Test Receiver	Rohde & Schwarz FSU	3831	2012-05	2013-05
Double Ridged Guide Ant.	Schwarzbeck BBHA 9120D	3235	2012-11	2014-11

6.3 Test Procedures

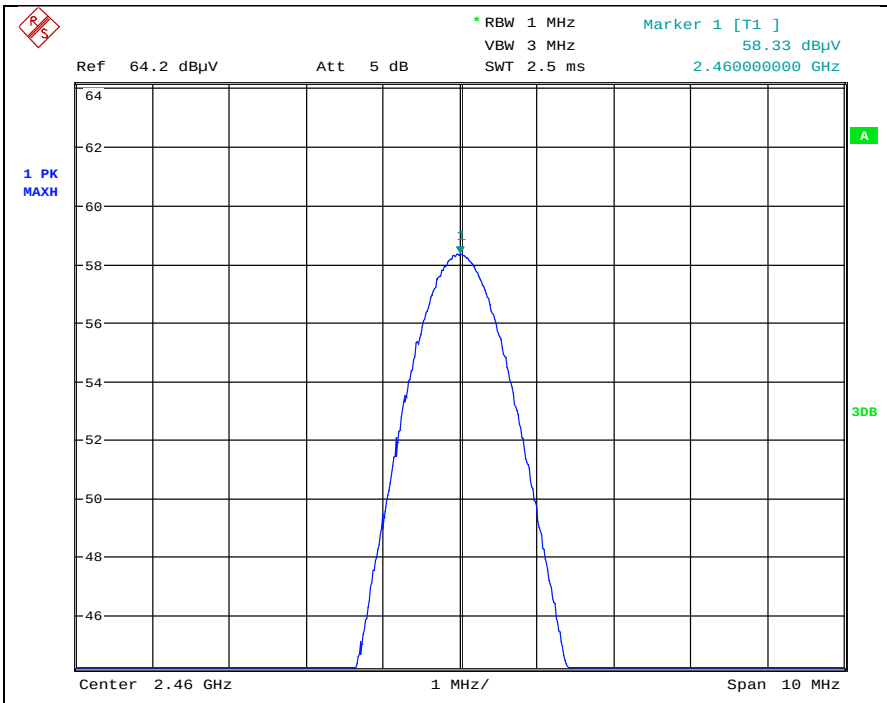
The EUT was tested on a 1.5 meter high non-conductive support for appropriate alignment with the receive antenna.
With the EUT operating in a fixed transmitting frequency mode, emissions from the unit are maximized by adjusting the polarization of the receive antenna and rotating the EUT on the turntable. 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).

6.4 Test Results

EUT mode	Fre-quency	Res/Video Bandwidth	Detec-tor	Dis-tance	Reading	Antenna Factor	Cable Att.	Result	Limit	Margin
	GHz	Hz		m	dBµV	dB/m	dB	dBµV/m	dBµV/m	dB
CW	2460	1 M / 3 M	Peak	3	58.3	27.9	1.0	87.2	114 Pk	26.8
CW	2460	1 M / 3 M	Peak	3	58.3	27.9	1.0	87.2	94 AV	6.8



EUT unmodulated (CW mode)

Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: iGenius Motorbrake
Type: T2021
Serial Number: 5137 (measurement was performed before modification as per chapter 2.5)

The EUT meets the requirements of this section.

Test Personnel: Manuel Zenk
Test Date: 2013-02-20

7 RADIATED SPURIOUS EMISSIONS

Test Requirement: FCC 47 CFR, Part 15 §249
Test Procedure: ANSI C63.4-2009

7.1 Regulation

Section 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.

Section 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	Field Strength	Measurement distance
(MHz)	(microvolts/meter)	(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 Section 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 Section 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 Section 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 Section 15.109 that are applicable to the incorporated digital device.

Section 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
EMI Test Receiver	Rohde & Schwarz FSU	3831	2012-05	2013-05
Double Ridged Guide Ant.	Schwarzbeck BBHA 9120D	3235	2012-11	2014-11
EMI Test Receiver	Rohde & Schwarz ESS	303	2013-02	2014-02
Loop Antenna	Rohde & Schwarz	374	2011-04	2014-04
Biconilog. Antenna	EMCO 3143	898	2011-05	2013-05

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

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

50 mV/m corresponds with 94 dBµV/m.

The maximum permitted unwanted emission level – except for harmonics - is 50 dB below the maximum permitted fundamental level, i.e. 44 dBµV/m or general radiated limits in §15.209 (54 dBµV/m for frequencies above 960 MHz), whichever is lesser attenuation. For harmonics a limit of 500 µV/m

corresponding with 54 dBµV/m applies. → Above 960 MHz the applicable limit for all emissions outside of the specified frequency band (2400 – 2483.5 MHz) is 54 dBµV/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:

Corrections Factor (dB) = 20*log (worst case on time/100 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:
FS = RA + AF + CF
where
FS = Field Strength in dBµV/m
RA = Receiver Amplitude in dBµV
AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB
Assume a receiver reading of 23.5 dBµV 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 dBµV/m. The 32 dBµV/m value can be mathematically converted to its corresponding level in µV/m.
FS = 23.5 + 7.4 + 1.1 = 32 [dBµV/m]
Level in µV/m = Common Antilogarithm (32/20) = 39.8

Note: For measurement up to 1000 MHz the Antenna Factor already includes the cable attenuation.
For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f)(1) the field strength is calculated by adding additionally an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements). The basic equation with a sample calculation is as follows:
FS = FST + DF
where
FS = Field Strength in dBµV/m
FST = Field Strength at test distance in dBµV/m
DF = Distance Extrapolation Factor in dB,
where DF = 20 log (Dtest/Dspec) where Dtest = Test Distance and Dspec = Specified Distance
Assume the tests performed at a reduced Test Distance of 1.5 m instead of the Specified Distance of 3 m giving a Distance Extrapolation Factor of DF = 20 log(1.5m/3m) = -6 dB.
Assuming a measured field strength level of 32 dBµV/m is obtained. The Distance Factor of -6 dB is added, giving a field strength of 26 dBµV/m. The 26 dBµV/m value can be mathematically converted to its corresponding level in µV/m.
FS = 23.5 + 7.4 + 1.1 - 6 = 26 [dBµV/m]
Level in µV/m = Common Antilogarithm (26/20) = 20

Note: Emissions above 1 GHz measured with a receiver reading in dBm.
For the 50 Ohms system a conversion factor of +107 dB is applicable to convert dBm into dBµV.

The field strength is calculated as follows:

FS = RA_{dBm} + 107 + AF + CF
where
FS = Field Strength in dBµV/m
RA_{dBm} = Receiver Amplitude in dBm
AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB
Assume a receiver reading of -89 dBm is obtained. The Conversion Factor of +107 dB, the Antenna Factor of 27.9 dB(1/m) and a Cable Factor of 0.6 dB are added, giving a field strength of 46.5 dBµV/m. The 46.5 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

FS = -89 + 107 + 27.9 + 0.6 = 46.5 [dBµV/m]

7.7 Test Results

EUT mode	Frequency	Distance	Reading	Antenna Factor	Cable Att.	Result at test distance	Distance Corr.	3 m Result	3 m Limit	Margin
	MHz	m	dBµV	dB	dB	dBµV/m	dB	dBµV/m	dBµV/m	dB
run	41.96	3	18.1	10.2	--	28.3	0	28.3	40	11.7
run	77.48	3	28.5	9.7	--	38.2	0	38.2	40	1.8
run	130.68	3	20.7	10.3	--	31.0	0	31.0	43.5	12.5
run	173.16	3	21.2	11.4	--	32.6	0	32.6	43.5	10.9
run	345.08	3	22.9	18.4	--	41.3	0	41.3	46	4.7
run	432.02	3	19.8	20.3	--	40.1	0	40.1	46	5.9
CW	4920	1	24.0	31.3	2.2	57.6	-9.5	48.1	54	5.9
CW	7380	1	8.3	36.2	2.6	47.1	-9.5	37.6	54	16.4
CW	9840	1	7.7	38.3	2.6	48.6	-9.5	39.1	54	14.9

For detailed test data plots please refer to the following pages.

Measurement was performed in worst case operation mode.

Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: iGenius Motorbrake
Type: T2021
Serial Number: 5137 (measurements in CW mode were performed before modification as per chapter 2.5, measurements in run mode were performed after modification as per chapter 2.5)

The EUT meets the requirements of this section.

Test Personnel: Manuel Zenk
Test Date: 2013-02-18/19/20/25/26

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

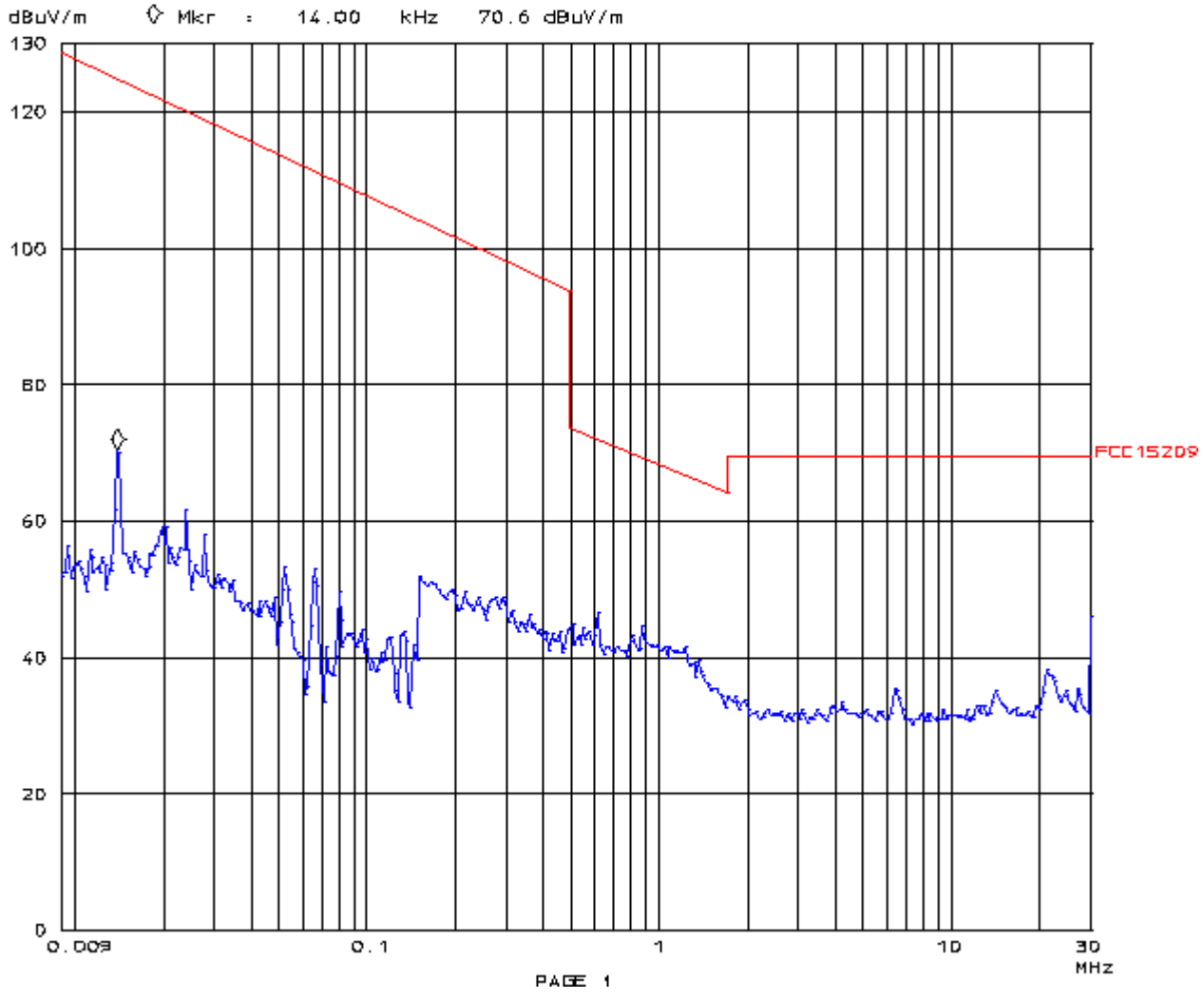
EMCCons DR. RASEK 18. Feb 13 13:01
Radiated Emissions H Field in SAR, d=3m

EUT: Genius Brake #5137
Manuf: EBE
Op Cond: standby, CW
Operator: Zenk
Test Spec: FCC 15C
Comment: 4 axes, ant: 1, _

Scan Settings (2 Ranges)

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

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



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

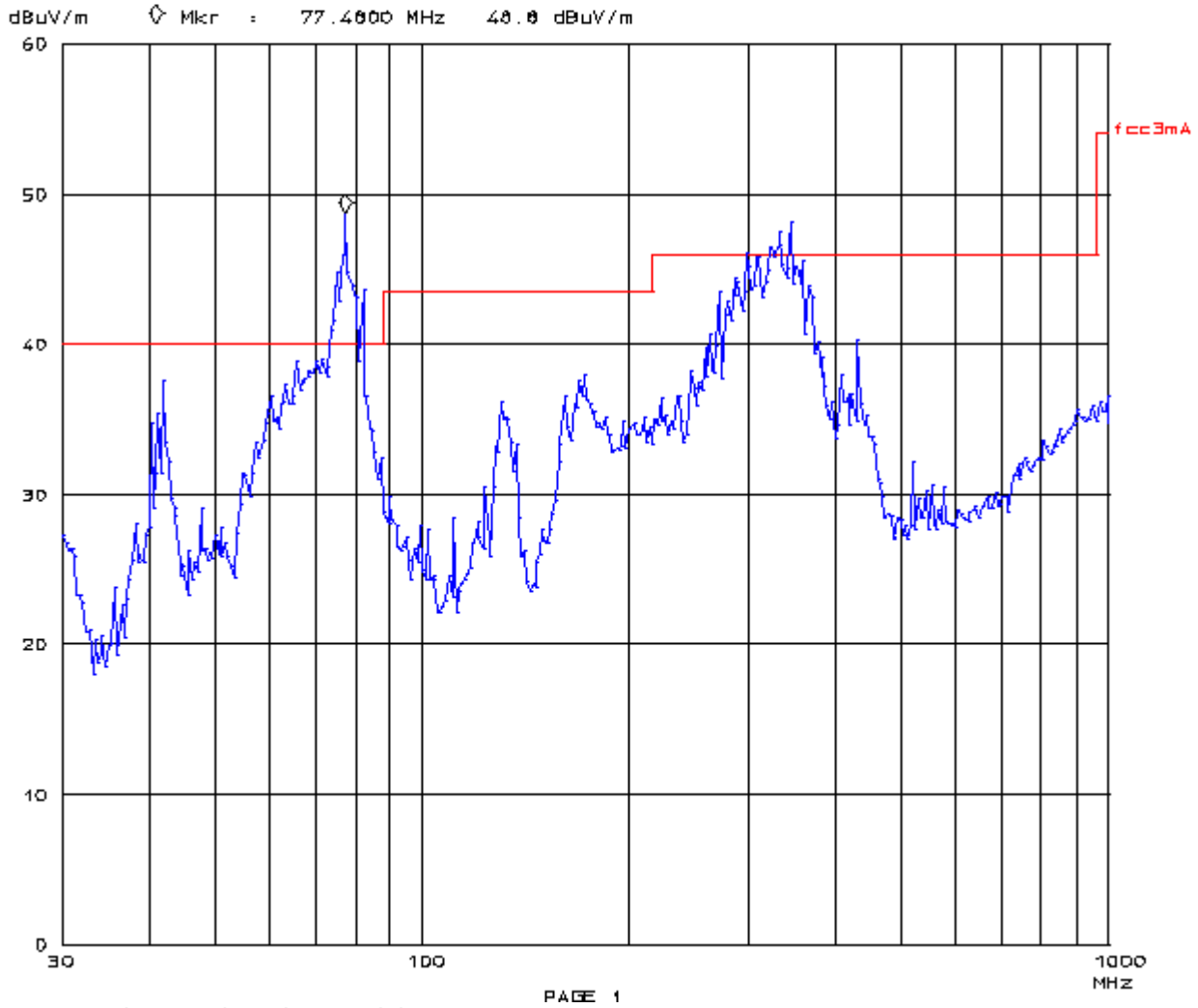
EMCCons DR. RASEK 25. Feb 13 17:12
Radiated Emissions Prescan in SAR, d=3m

EUT: GENIUS Brake #5137
Manuf: EBE GmbH
Op Cond: running
Operator: Zenk
Test Spec: FCC15
Comment: 4 directions 3/4 height

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	0dBLN	ON	60dB

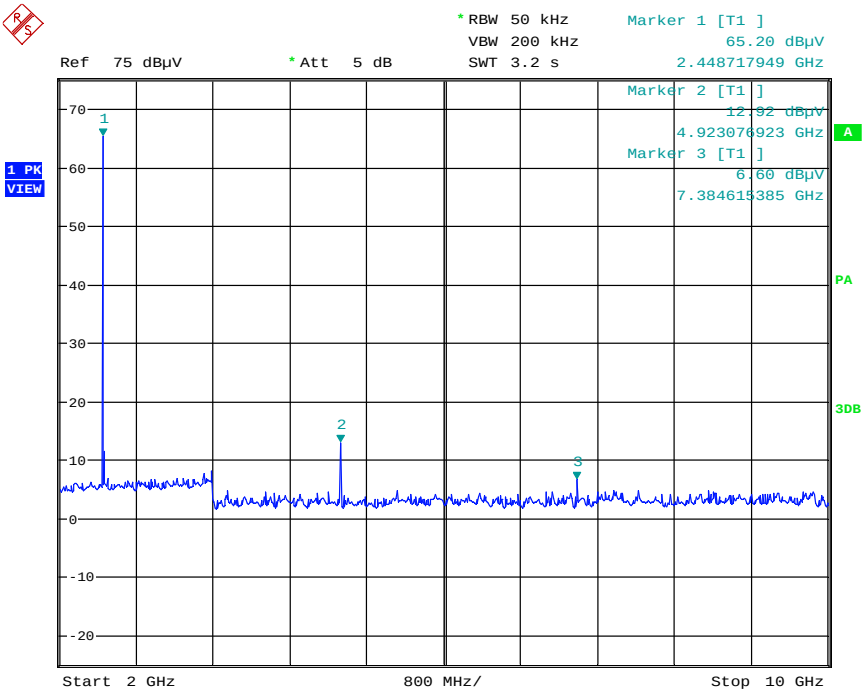
Transducer	No.	Start	Stop	Name
	Z1	30M	1000M	8958643 3



Prescan d = 3 m (running mode)

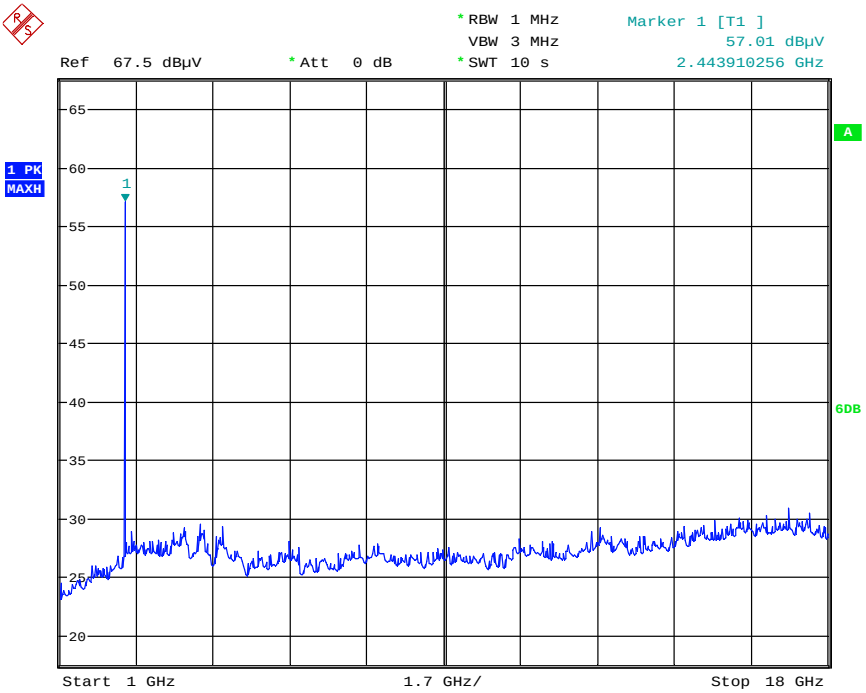
7.7.3 Electric Field (f = 1 GHz to 25 GHz)

Sample plots CW mode



Date: 20.FEB.2013 14:16:02

Analyzer reading (pre-scan, antenna factor + cable att. to be added); d = 1 m (dist. corr. factor = -9.5 dB)



Date: 19.FEB.2013 15:18:51

Analyzer reading (antenna factor + cable att. to be added); d = 3 m

[18 – 25 GHz - no plot recorded]
Analyzer reading (antenna factor + cable att. to be added); d = 1 m (dist. corr. factor = -9.5 dB)
- no emissions found above 18 GHz

8 BAND-EDGE EMISSIONS

Test Requirement: FCC §15.249
Test Procedure: ANSI C63.10 – 2009 §6.9.2

8.1 Regulation

FCC §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
EMI Test Receiver	Rohde & Schwarz FSU	3831	2012-05	2013-05
Double Ridged Guide Ant.	Schwarzbeck BBHA 9120D	3235	2012-11	2014-11

8.3 Test Procedure

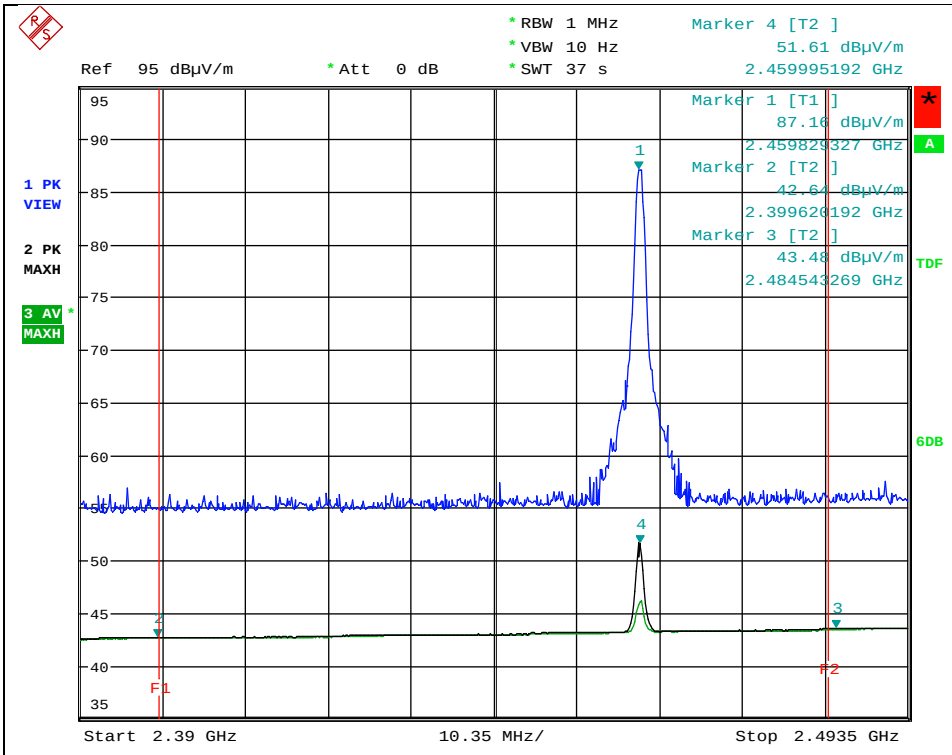
Connect the spectrum analyzer to the EUT using an appropriate RF cable connected to the EUT output. Configure the spectrum analyzer settings as described below (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).

– Span: Set Span for minimum 50 MHz
– Reference Level: 110 dBµV (corrected for gains and losses of test antenna factor, preamp gain and cable loss)
– Attenuation: 10 dB
– Sweep Time: Coupled
– Resolution Bandwidth: Up to and including 1 GHz ≥ 100 kHz
– Resolution Bandwidth: Above 1 GHz = 1 MHz
– Video Bandwidth: Below 1 GHz = 300 kHz
– Video Bandwidth: Up from and including 1 GHz ≥ 3 MHz for peak and10 Hz for average
– 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.

8.4 Test Results

Frequency [MHz]	Reading [dBµV/m]	Limit [dBµV/m]	Margin [dB]
2400	42.6	54.0	11.4
2484.5	43.5	54.0	10.5



EUT modulated (random data)
Trace T1: 3 MHz VBW; Trace T2: 10 Hz VBW; Trace T3: 10 Hz VBW AV (informative, only)

Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: iGenius Motorbrake
Type: T2021
Serial Number: 5137 (measurement was performed after modification as per chapter 2.5)

The EUT meets the requirements of this section.

Test Personnel: Manuel Zenk
Test Date: 2013-03-06

9 EMISSION BANDWIDTH

Test Requirement: FCC §15.215
Test Procedure: ANSI C63.10 – 2009 §6.9.1

9.1 Regulation

FCC §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.

Type	Manufacturer/ Model No.	EMCC Ident No.	Last Calibration	Next Calibration
EMI Test Receiver	Rohde & Schwarz FSU	3831	2012-05	2013-05
Double Ridged Guide Ant.	Schwarzbeck BBHA 9120D	3235	2012-11	2014-11

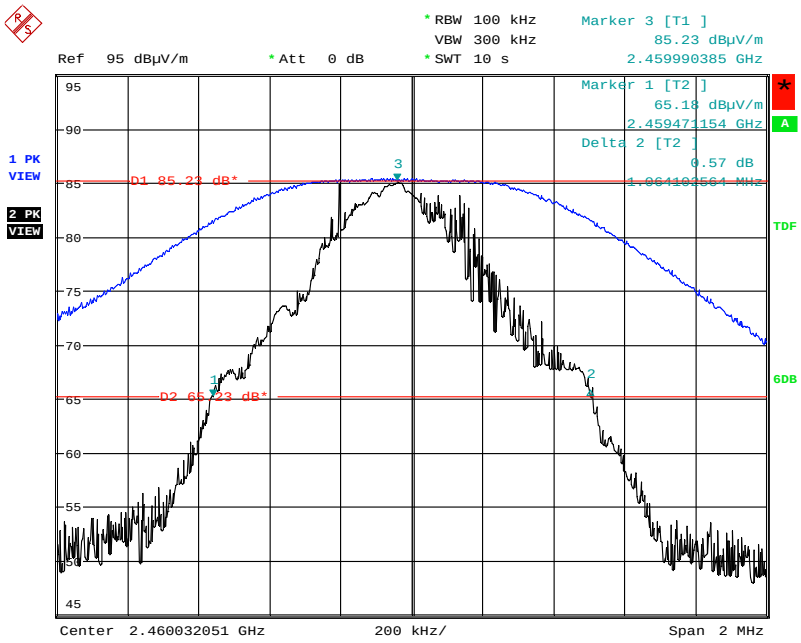
9.2 Test Procedures

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.
a) 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.
b) 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.
1) The span range for the SA display shall be between two times and five times the OBW.
2) 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.
3) 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
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	1064



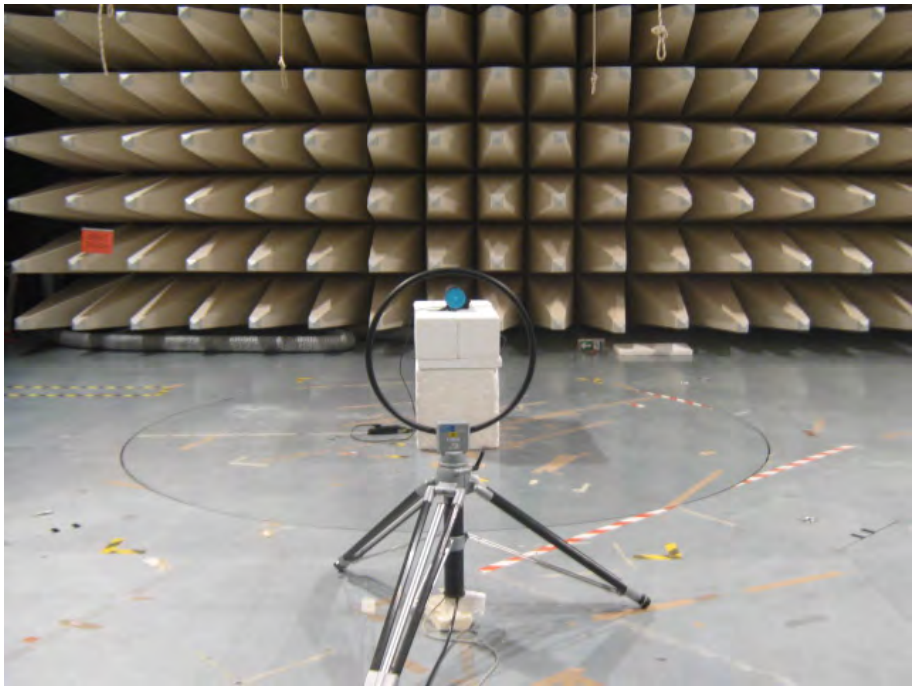
Date: 19.FEB.2013 15:14:18

Manufacturer: EBE Elektro-Bau-Elemente GmbH
Device: iGenius Motorbrake
Type: T2021
Serial Number: 5137

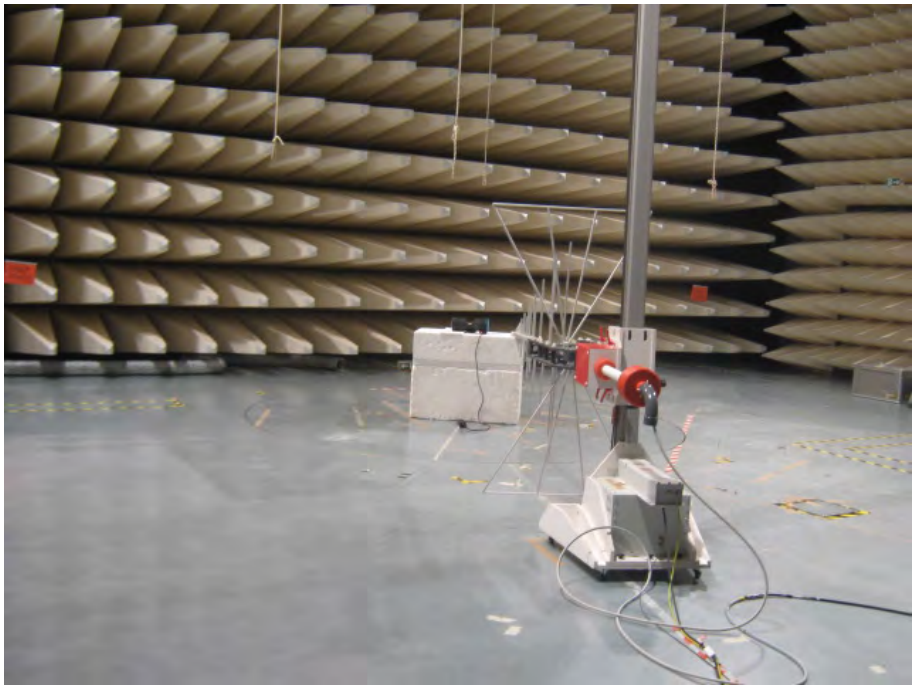
The EUT meets the requirements of this section.

Test Personnel: Manuel Zenk (measurement was performed before modification as per chapter 2.5)
Test Date: 2013-02-19

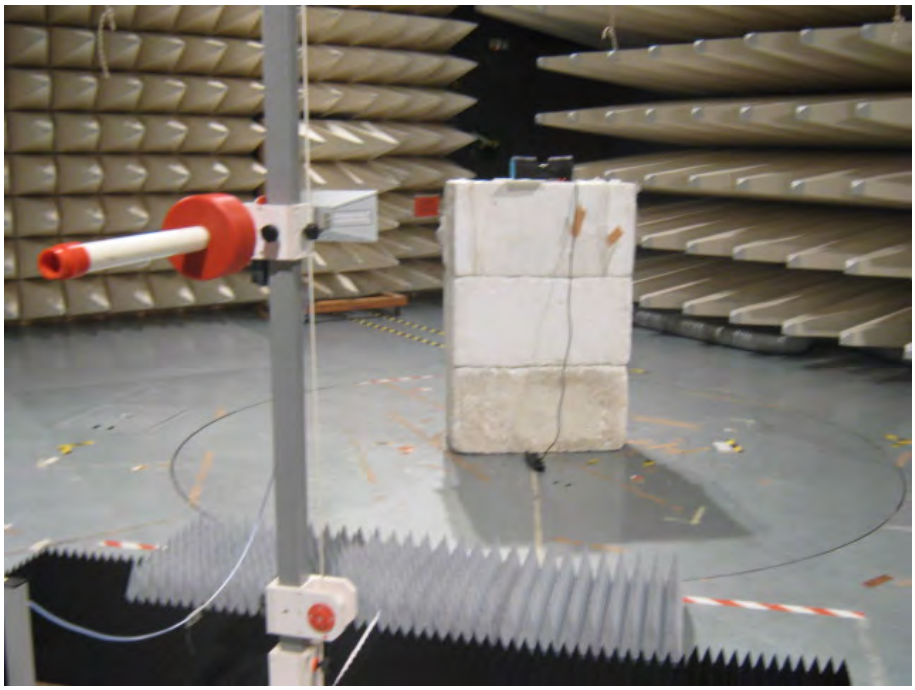
APPENDIX 1 - PHOTOGRAPHS OF TEST SETUP



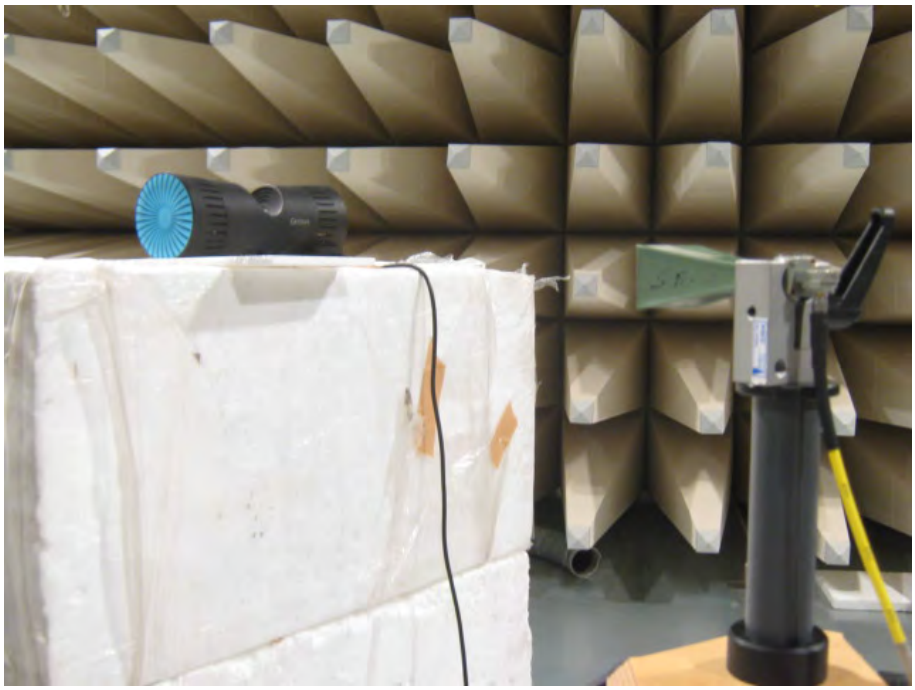
Photograph A1-1: H-Field measurement



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



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



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

APPENDIX 2 - PHOTOGRAPHS OF EUT; EXTERNAL VIEW

Photograph A2-1: Top view

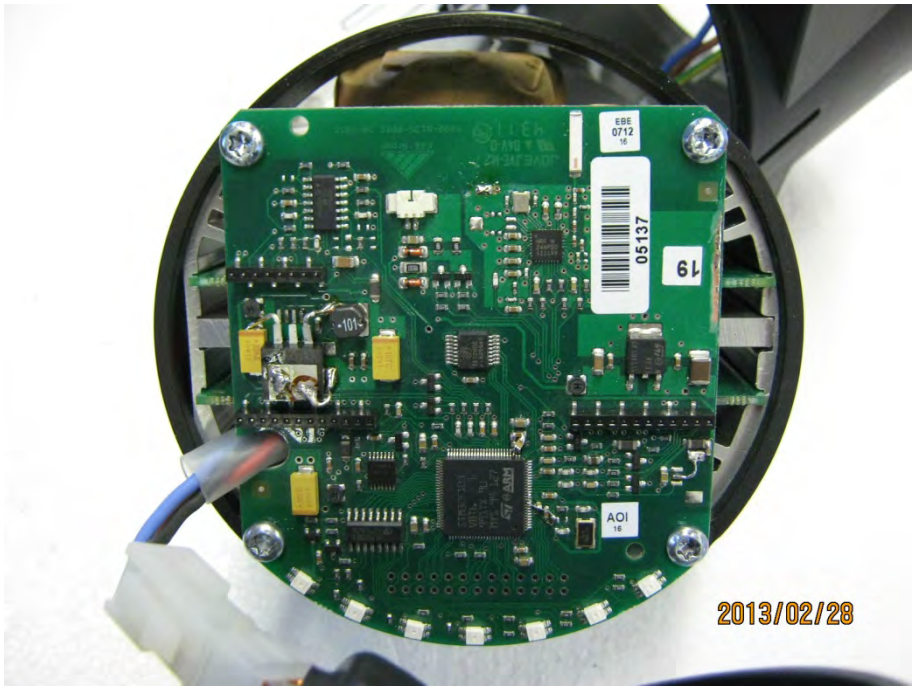
Photograph A2-2: Bottom view

Photograph A2-3: Close-up front view

Photograph A2-4: Right side view

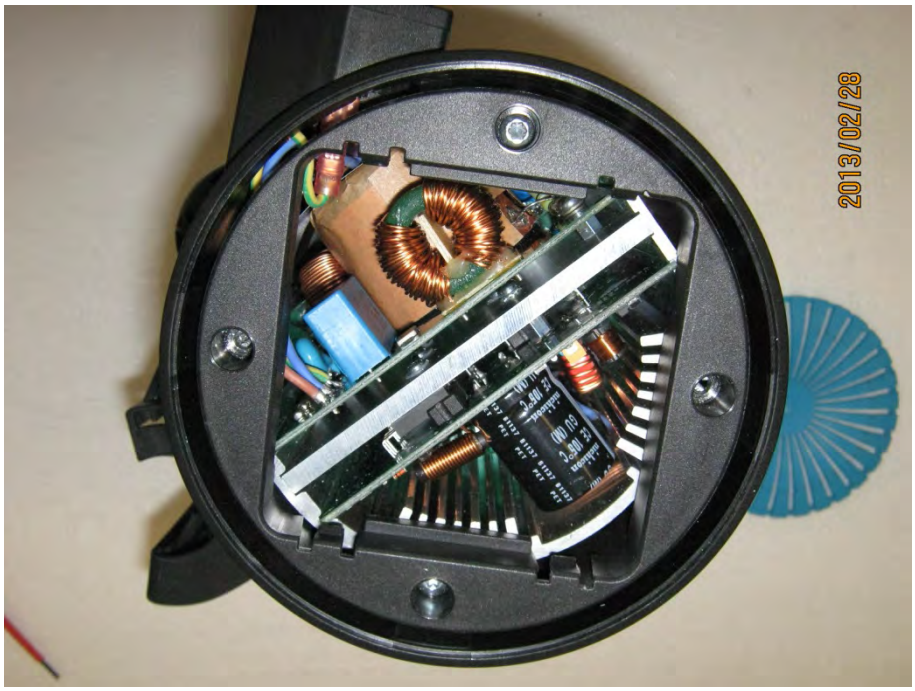
Photograph A2-5: Left side view

APPENDIX 3 - PHOTOGRAPHS OF EUT; INTERNAL VIEW

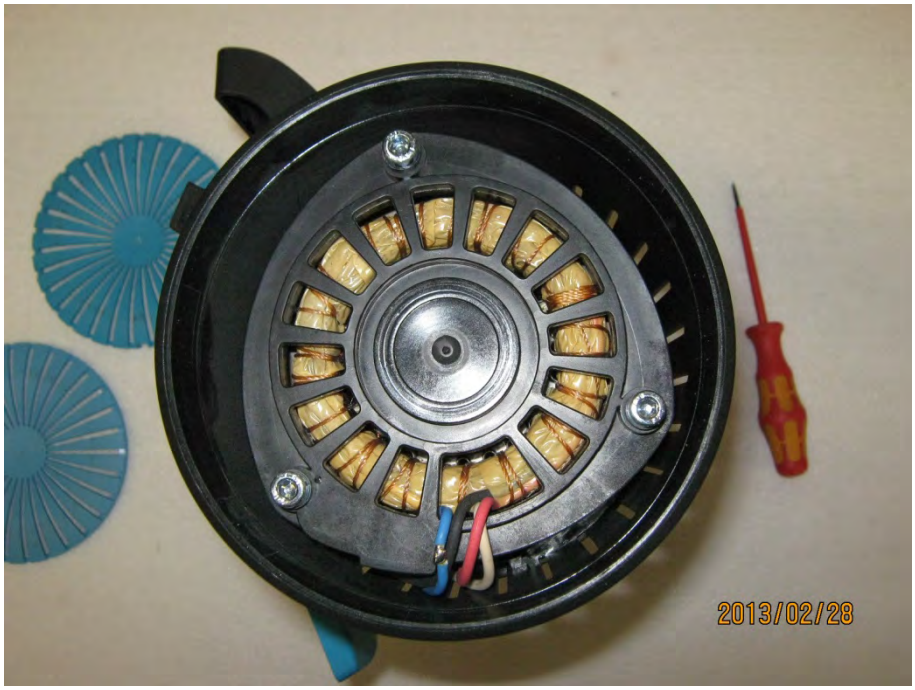


Photograph A3-1: Internal view – Transceiver board, Top view

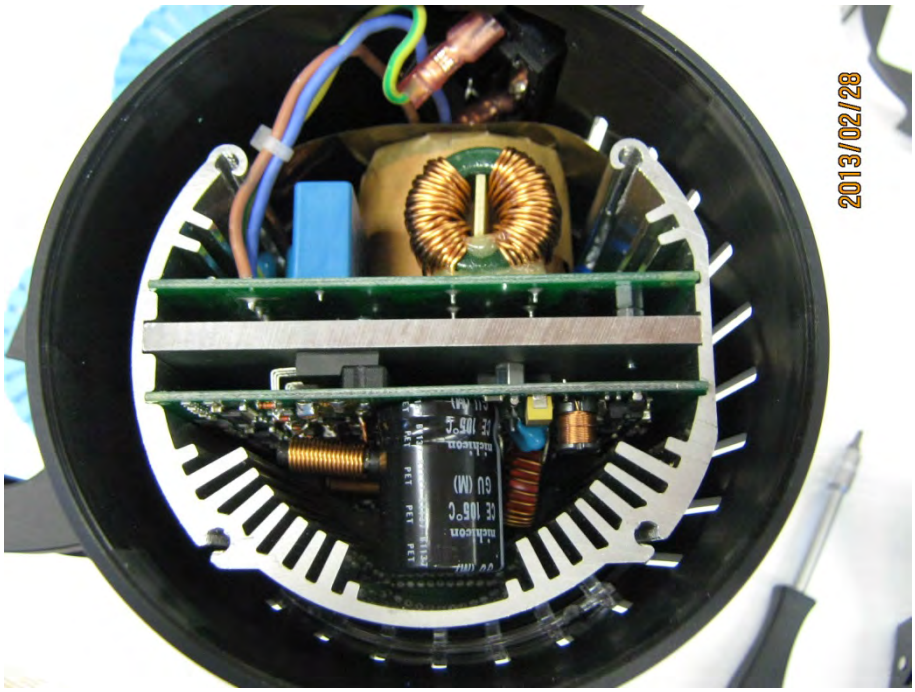
Photograph A3-2: Close-up view of the transceiver PCB



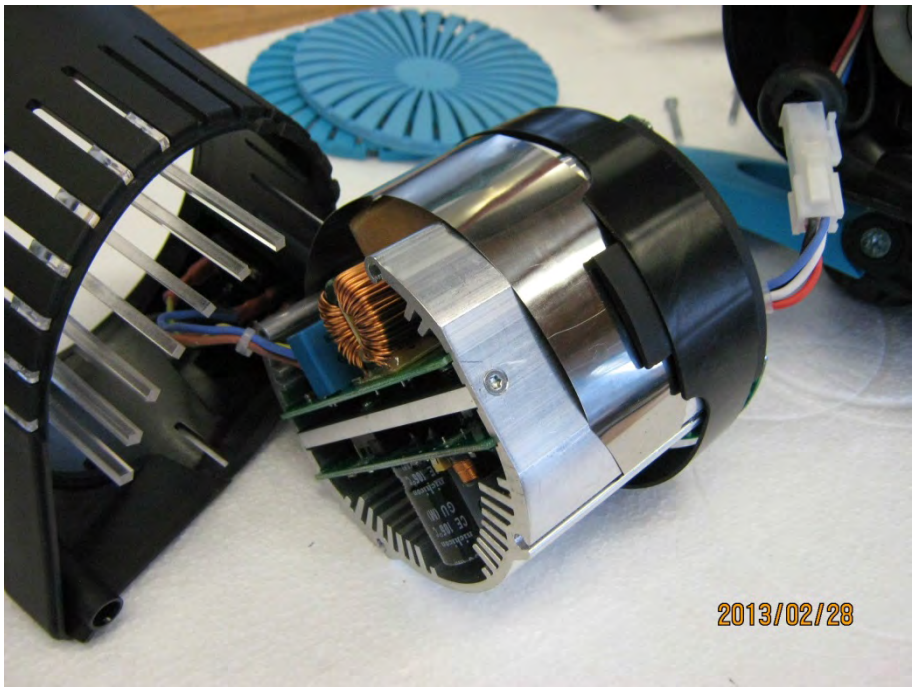
Photograph A3-3: Internal view, right side, plastic cover removed



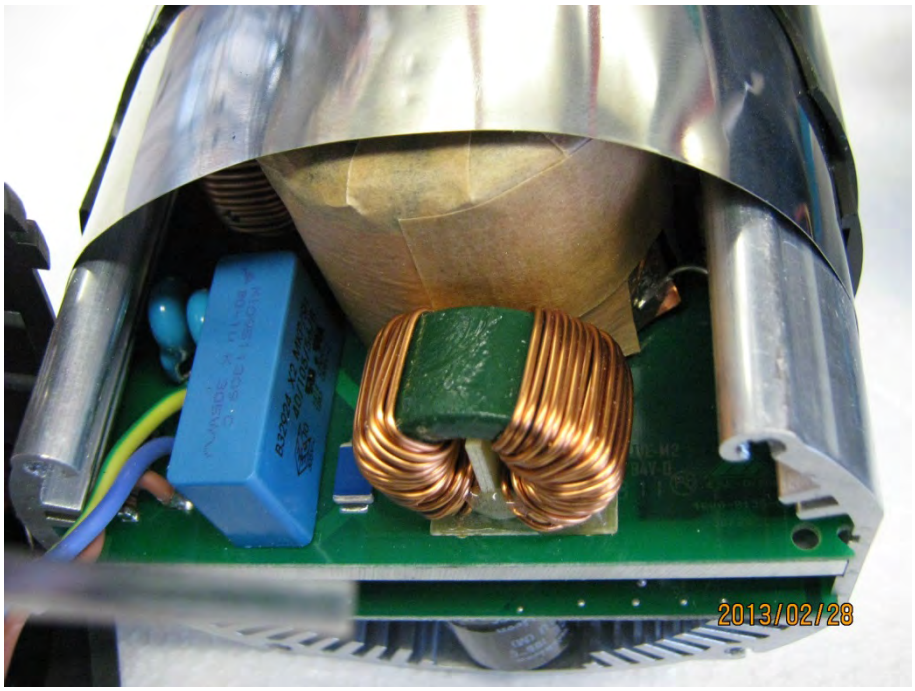
Photograph A3-4: Internal view, left side, plastic cover removed



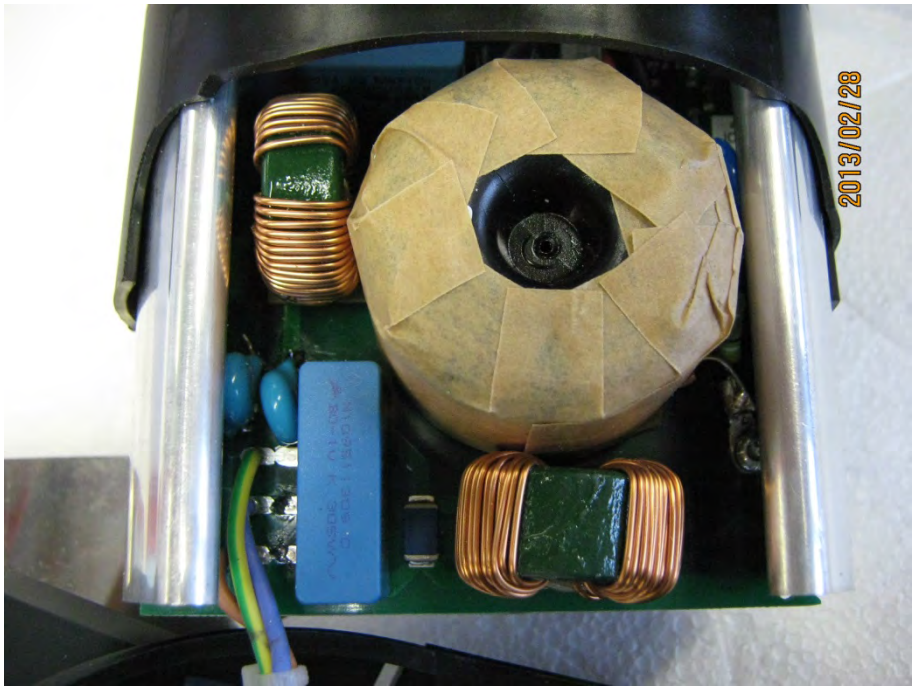
Photograph A3-5: Internal view



Photograph A3-6: Internal view



Photograph A3-7: Internal view



Photograph A3-8: Internal view