

FCC ID: PWPGTR-EASY-2400

## EMI -- TEST REPORT

Test Report No. :

**T30195-01-00XF**

October 12, 2005

Date of issue

Type / Model Name : Funkmodul 2.4 GHz GTR/SA Kpl.  
Funkmodul 2.4 GHz EASY Kpl.

Product Description : 2.4 GHz radio module for transmitting measurement data from different wheel alignment systems.

Applicant : Beissbarth GmbH

Address : Hanauer Straße 101  
D-80993 München

Manufacturer : Beissbarth GmbH

Address : Am Industriepark 11  
D-84453 Mühldorf a. Inn

Licence holder : Beissbarth GmbH

Address : Hanauer Straße 101  
D-80993 München

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

**Positive**



FCC ID: PWPGTR-EASY-2400

## Contents

<b>1 TEST STANDARDS</b>	<b>3</b>
<b>2 SUMMARY</b>	<b>4</b>
<b>3 EQUIPMENT UNDER TEST</b>	<b>5</b>
3.1 PHOTO DOCUMENTATION OF THE EUT	5
3.2 POWER SUPPLY SYSTEM UTILISED	12
3.3 SHORT DESCRIPTION OF THE EQUIPMENT UNDER TEST (EuT)	12
<b>4 TEST ENVIRONMENT</b>	<b>13</b>
4.1 ADDRESS OF THE TEST LABORATORY	13
4.2 ENVIRONMENTAL CONDITIONS	13
4.3 STATEMENT OF THE MEASUREMENT UNCERTAINTY	13
4.4 MEASUREMENT PROTOCOL FOR FCC, VCCI AND AUSTEL	13
<b>5 TEST CONDITIONS AND RESULTS</b>	<b>15</b>
5.1 CONDUCTED EMISSIONS	15
5.2 RADIATED POWER OF THE FUNDAMENTAL WAVE	16
5.3 RADIATED EMISSIONS (ELECTRIC FIELD) 9 kHz – 40 GHz	19
5.4 EMISSION BANDWIDTH	27
5.5 BAND EDGE TEST	32
5.6 CORRECTION FOR PULSE OPERATION (DUTY CYCLE)	36
5.7 ANTENNA APPLICATION	41
5.8 RECEIVER CONDUCTED DISTURBANCES 0.15 - 30 MHz	42
5.9 RECEIVER RADIATED EMISSIONS (ELECTRIC FIELD) 9 kHz - 40 GHz	43
<b>6 USED TEST EQUIPMENT AND ACCESSORIES</b>	<b>48</b>

**FCC ID: PWPGR-EASY-2400**

## **1 TEST STANDARDS**

The tests were performed according to following standards:

FCC Rules and Regulations Part 15 Subpart C - Intentional Radiators (October 01, 2004)

Part 15, Subpart C, Section 15.249	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz
Part 15, Subpart C, Section 15.35(c)	Correction for Pulse Operation (Duty Cycle)
Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.207(a)	AC Line conducted emissions
Part 15, Subpart C, Section 15.209(a)	Radiated emissions, general requirements
Part 15, Subpart C, Section 15.215(c)	Additional provisions to the general radiated emission limitations
ANSI C63.4-2003, Section 13.1.7	Occupied bandwidth measurements

FCC Rules and Regulations Part 15 Subpart B - Unintentional Radiators (October 01, 2004)

Part 15, Subpart B, Section 15.107(a)	AC Line conducted emissions
Part 15, Subpart B, Section 15.109(a)	Radiated emissions, general requirements

FCC ID: PWPGR-EASY-2400

## **2 SUMMARY**

### **GENERAL REMARKS:**

It exists two modules "Funkmodul 2.4 GHz GTR/SA Kpl." and "Funkmodul 2.4 GHz EASY Kpl." Both modules are 100% identical, except the antenna connector. On the EASY-Module the antenna connector is mounted on the solder side of the PCB and on the GTR/SA-Module the antenna connector is mounted on the components side of the PCB.

### **FINAL ASSESSMENT:**

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample	: <u>acc. to storage records</u>
Testing commenced on	: <u>October 10, 2005</u>
Testing concluded on	: <u>October 12, 2005</u>

Checked by:

Tested by:

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

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Fischer Xaver

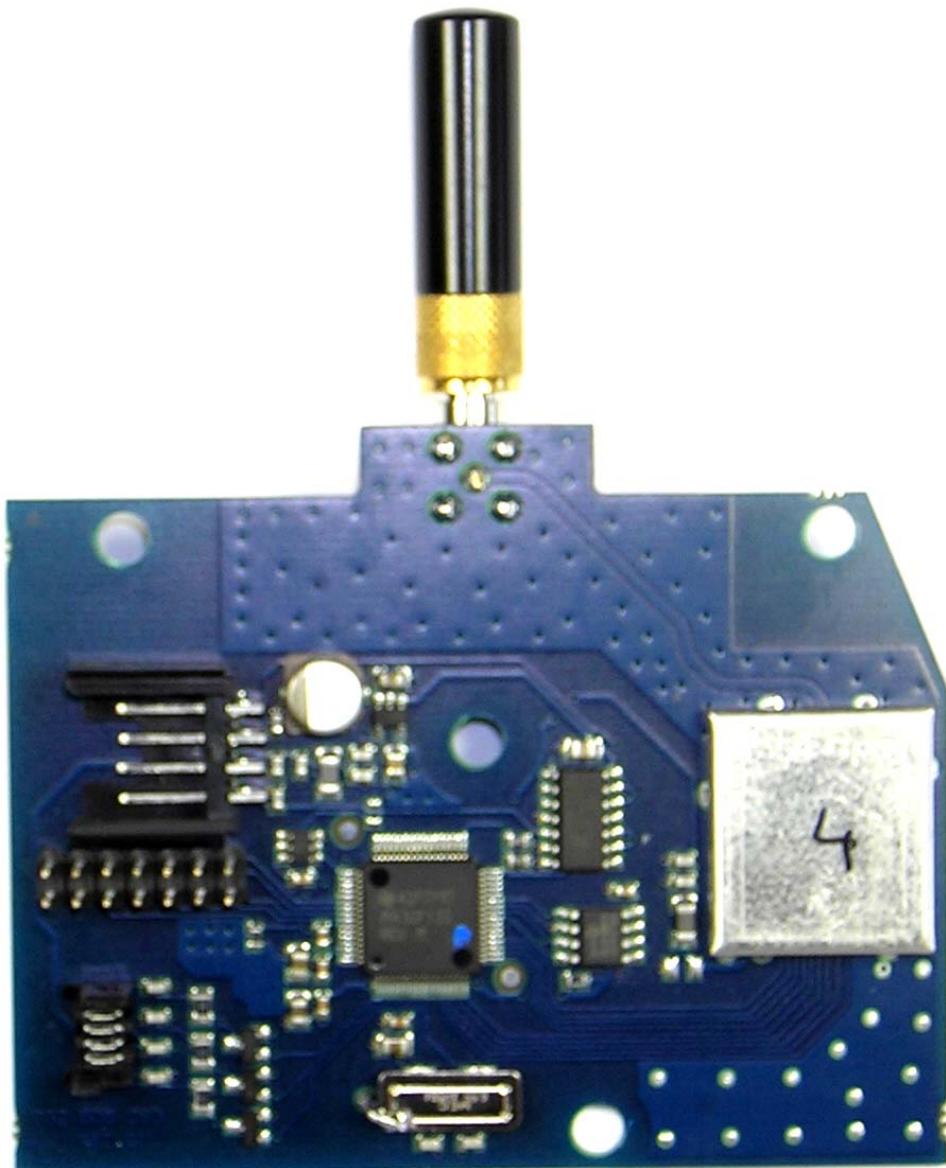
FCC ID: PWPGR-EASY-2400

### **3 EQUIPMENT UNDER TEST**

#### **3.1 Photo documentation of the EuT**

**2.4 GHz Transceiver module**  
T30195-01-00XF

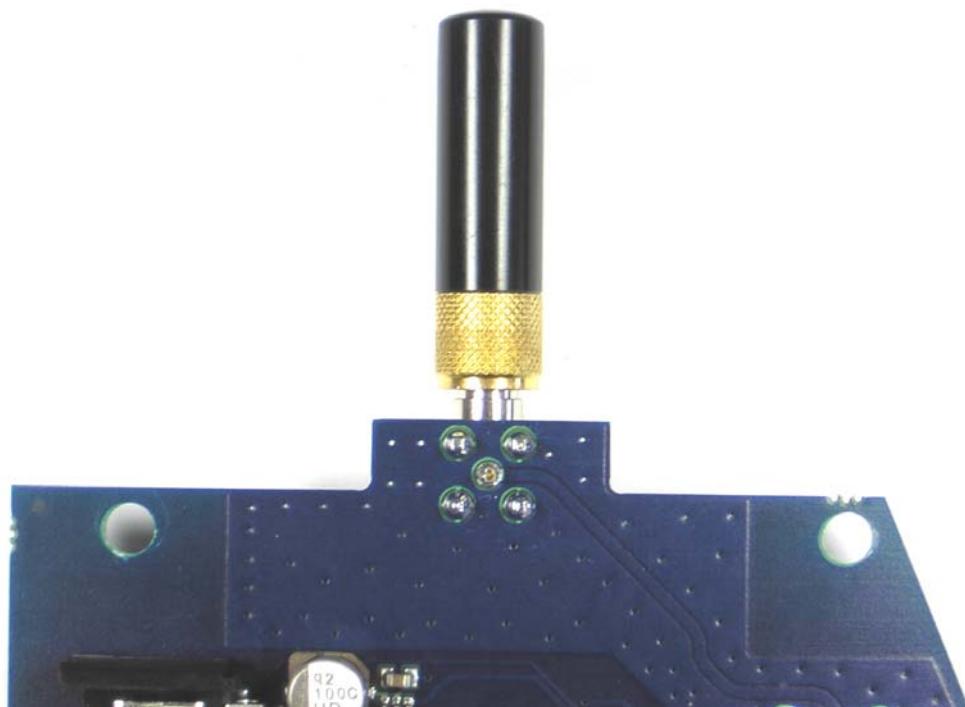
External Photo  
Front view with RF-shielding



FCC ID: PWPGR-EASY-2400

**2.4 GHz Transceiver module**  
T30195-01-00XF

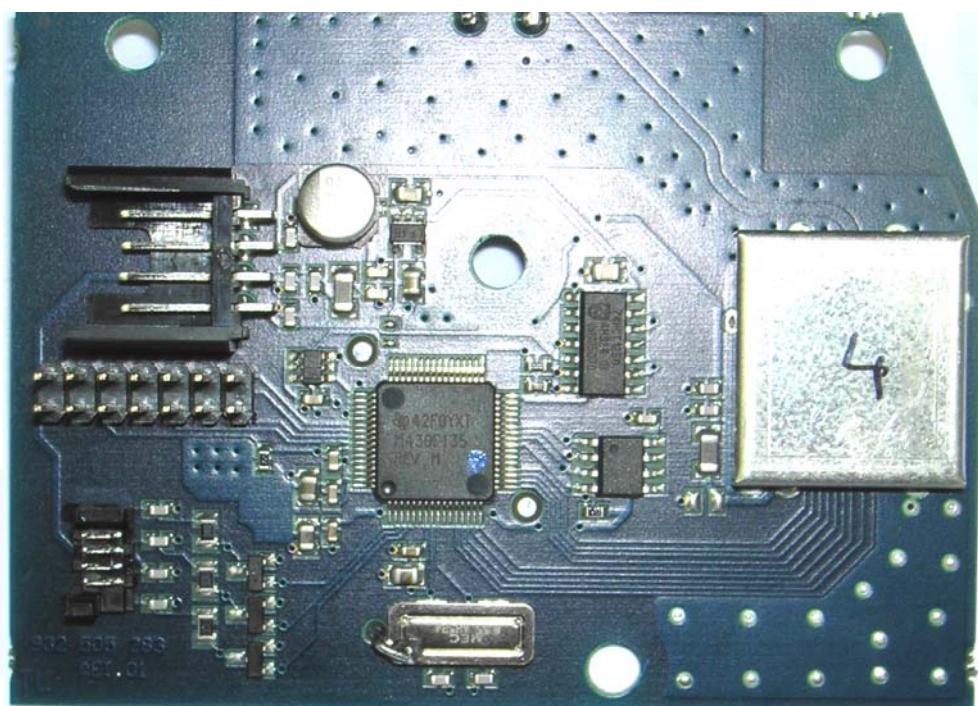
External Photo  
Part view of PCB



**FCC ID: PWPGR-EASY-2400**

**2.4 GHz Transceiver module**  
T30195-01-00XF

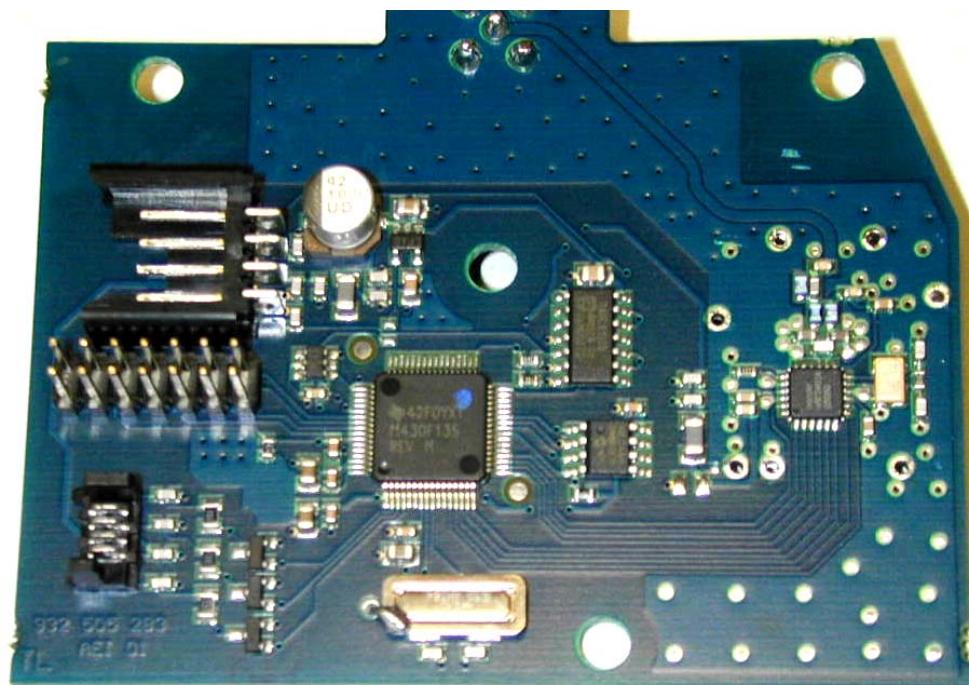
External Photo  
Part view of PCB with RF-shielding



**FCC ID: PWPGR-EASY-2400**

**2.4 GHz Transceiver module**  
T30195-01-00XF

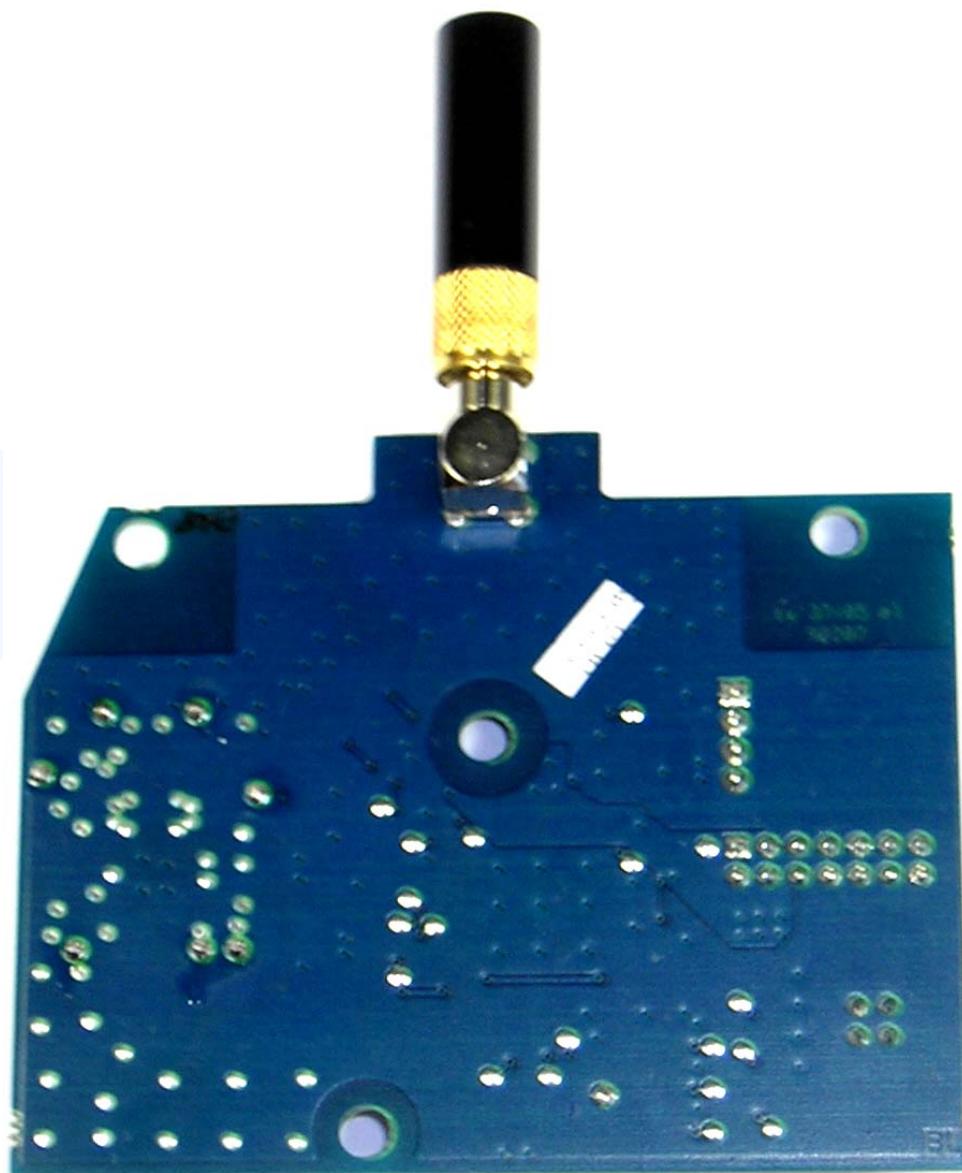
External Photo  
Part view of PCB without RF-shielding



FCC ID: PWPGR-EASY-2400

**2.4 GHz Transceiver module**  
T30195-01-00XF

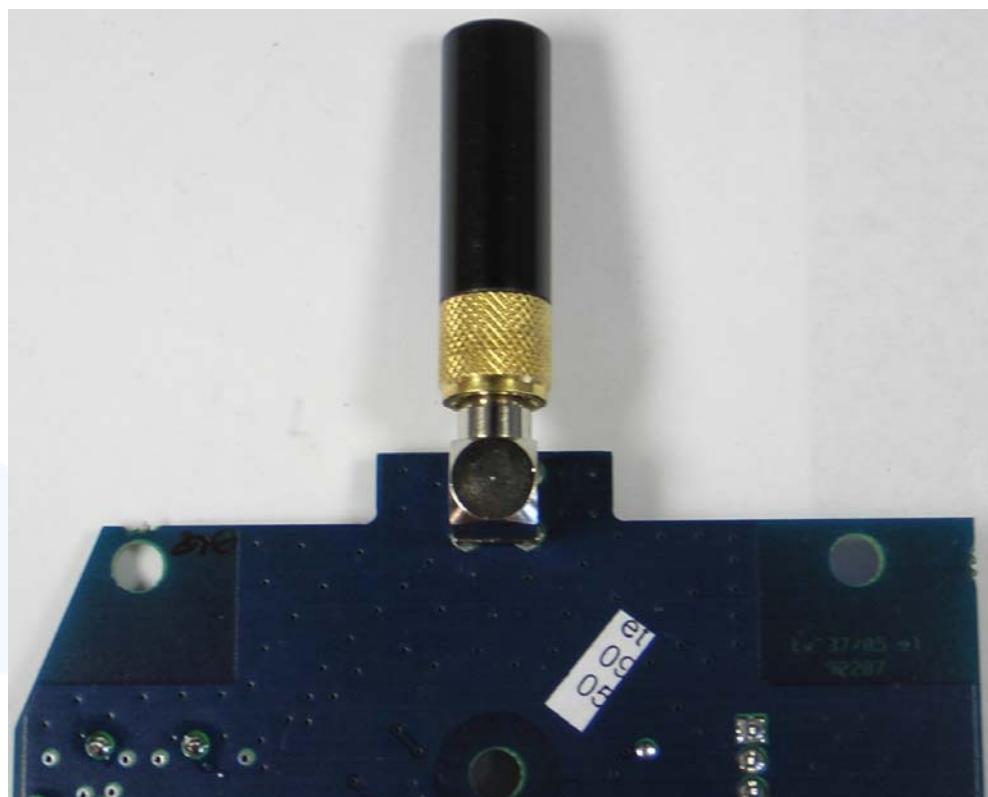
External Photo  
Rear view



**FCC ID: PWPGTR-EASY-2400**

**2.4 GHz Transceiver module**  
T30195-01-00XF

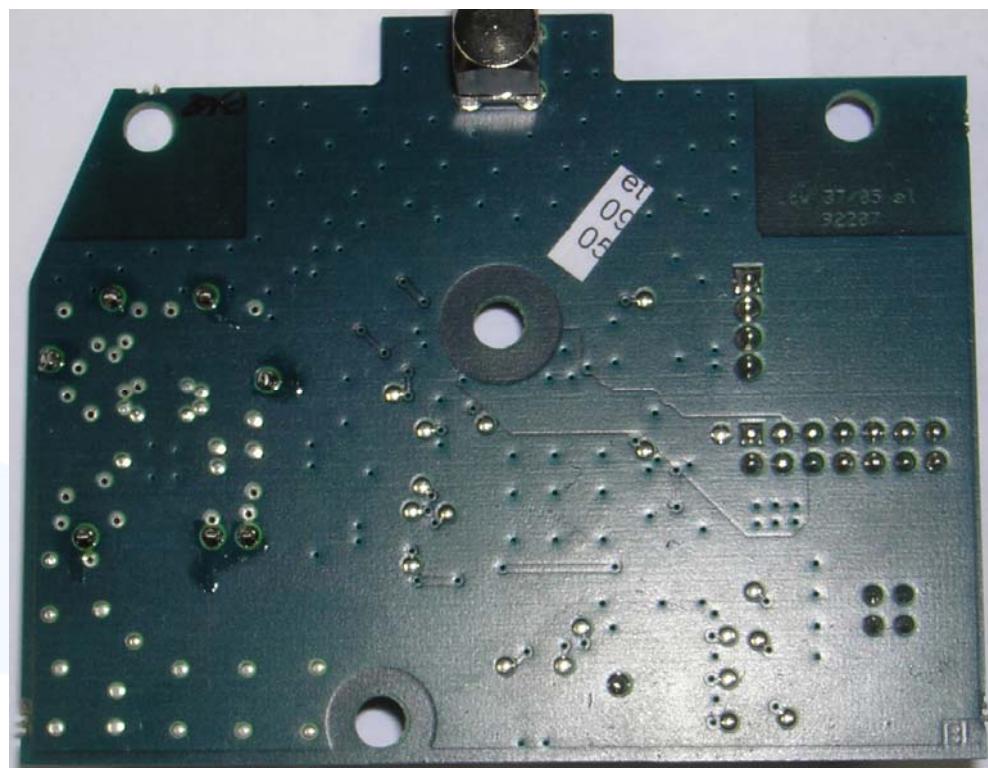
External Photo  
Part view of PCB



**FCC ID: PWPGR-EASY-2400**

**2.4 GHz Transceiver module**  
T30195-01-00XF

External Photo  
Part view of PCB



FCC ID: PWPGTR-EASY-2400

### 3.2 Power supply system utilised

Power supply voltage : 4,5 V / DC

### 3.3 Short description of the Equipment under Test (EuT)

Both radio communication modules "Funkmodul 2.4 GHz EASY kpl. (932.503.144)" and "Funkmodul 2.4 GHz GTR/SA kpl. (932.503.168)" are exclusively used for different Beissbarth wheel alignment systems. Therefore the modules are mounted inside the measuring heads and the cabinet of a wheel alignment system. The radio modules are used to transmit control data from the cabinet to the measuring heads and measuring results from the measuring heads back to the cabinet.

The modules work within the 2.4GHz band and perform a bidirectional data link.

Number of tested samples: 1  
Serial number: Prototype

## EuT operation mode:

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

- TX-mode with modulation

- TX-mode without modulation

### - RX-mode

## EUT configuration:

(The CDF filled by the applicant can be viewed at the test laboratory.)

**The following peripheral devices and interface cables were connected during the measurements:**

- Laptop
- 
- 
- 
- 
- 
-

Model : Toshiba

Model : \_\_\_\_\_

FCC ID: PWPGR-EASY-2400

## 4 TEST ENVIRONMENT

### 4.1 Address of the test laboratory

**mikes-testingpartners gmbh**  
Ohmstrasse 2-4  
94342 Strasskirchen  
Germany

### 4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 ° C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

### 4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 /11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

### 4.4 Measurement Protocol for FCC, VCCI and AUSTEL

#### 4.4.1 GENERAL INFORMATION

##### 4.4.1.1 Test Methodology

Conducted and radiated disturbance testing is performed according to the procedures in International Special Committee on Radio Interference (CISPR) Publication 22 (1997), European Standard EN 55022 and Australian Standard AS 3548 (which are based on CISPR 22).

The Japanese standard, "Voluntary Control Council for Interference (VCCI) by Data Processing Equipment and Electronic Office Machines, Technical Requirements" is technically equivalent to CISPR 22 (1997). For official compliance, a conformance report must be sent to and accepted by the VCCI.

In compliance with FCC Docket 92-152, "Harmonization of Rules for Digital Devices Incorporate International Standards", testing for FCC compliance may be done following the ANSI C63.4-2003 procedures and using the CISPR 22 Limits.

**FCC ID: PWPGR-EASY-2400**

#### **4.4.1.2 Justification**

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into it's characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum disturbances from the unit.

#### **4.4.2 DETAILS OF TEST PROCEDURES**

##### **4.4.2.1 General Standard Information**

The test methods used comply with CISPR Publication 22 (1997), EN 55022 (2001) and AS 3548 (1992) - "Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment" and with ANSI C63.4-2003 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

FCC ID: PWPGR-EASY-2400

## 5 TEST CONDITIONS AND RESULTS

### 5.1 Conducted emissions

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

#### 5.1.1 Description of the test location

Test location:

#### 5.1.2 Photo documentation of the test set-up

#### 5.1.3 Description of Measurement

The final level, expressed in dB $\mu$ V, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC Limit or to the CISPR limit, which is equivalent to the Australian AS 3548 limit.

To convert between dB $\mu$ V and  $\mu$ V, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EuT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection, and a Line Impedance Stabilization Network (LISN), with  $50\Omega/50 \mu\text{H}$  (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeter's above the floor and is positioned 40 centimeter's from the vertical ground plane (wall) of the screen room. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

#### 5.1.4 Test result

Frequency range:

Min. limit margin:

**Remarks:** The measurement is not applicable because the EuT is batterie powered.

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FCC ID: PWPGR-EASY-2400

## 5.2 Radiated power of the fundamental wave

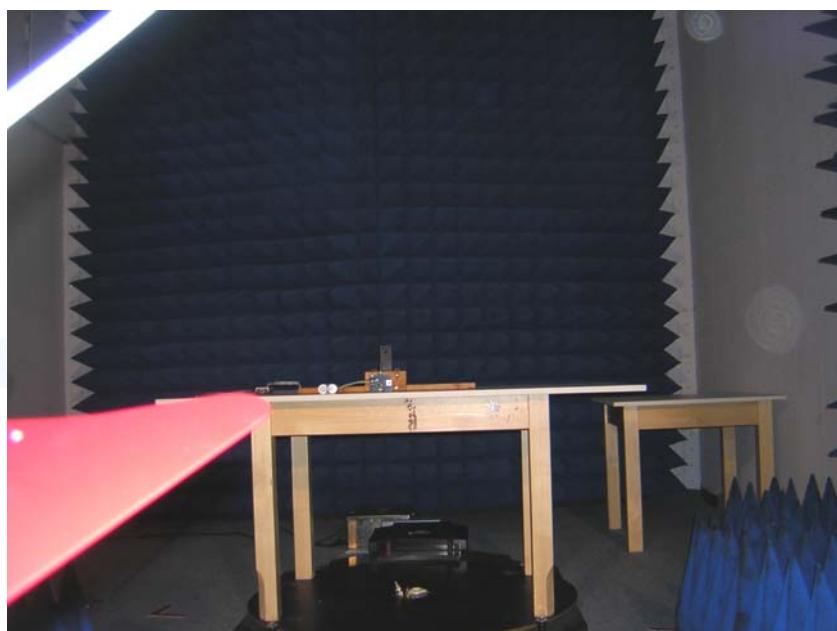
For test instruments and accessories used see section 6 Part **CPR 3**.

### 5.2.1 Description of the test location

Test location: Anechoic Chamber A2

Test distance: 3 metres

### 5.2.2 Photo documentation of the test set-up



**FCC ID: PWPGTR-EASY-2400****5.2.3 Description of Measurement**

The radiated power of the fundamental wave from the EUT is measured in the frequency range of 30 to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2003.

The Interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna was positioned 3, 10 or 30 meters horizontally from the EuT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarization's and the EuT are rotated 360 degrees.

The final level, expressed in dB $\mu$ V/m, is arrived by taking the reading from the EMI receiver (Level dB $\mu$ V) and adding the correction factors and cable loss factor (Factor dB) to it. This is done automatically in the EMI receiver, where the correction factors are stored. This result then has the FCC or CISPR limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets at page.

The radiated power of the fundamental wave from the EUT is measured in the frequency range above 1 GHz using a tuned receiver (Spectrum Analyser) and appropriate linearly polarized antennas. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2003.

The Interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna was positioned 3 horizontally from the EuT.

Measurement are made in both the horizontal and vertical planes of polarization in a fully anechoic room using a spectrum analyzer with the detector function set to peak and resolution as well as video bandwith set to 1 MHz. All tests are performed at a test-distance of 3 meters. Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration procedure the highest emission relative the limit and therefore shall be used for final testing. During the tests the EUT is rotated all around to find the maximum levels of emissions. The cables and equipment were placed and moved within the range of position likely to find their maximum emissions. When the EuT is larger than the beamwidth of the measuring antenna, the measurement antenna will be moved over the surfaces for the four sides or the test distance will be reduced to demonstrate that emissions were at maximum at the limit distance.

The resolution bandwidth during the measurement is as follows:

30 MHz – 1000 MHz:	ResBW: 120 kHz
1000 MHz – 40 GHz	ResBW: 1 MHz

FCC ID: PWPGTR-EASY-2400

#### 5.2.4 Test result

Channel low										
Frequency [MHz]	Reading Level PK [dB $\mu$ V]	Corr. Duty Cycle [dB]	Level AV [dB $\mu$ V] *)	Band-width [kHz]	Correct. Factor [dB]	Corrected Level PK [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit PK [dB $\mu$ V/m]	Limit AV [dB $\mu$ V/m]	Delta [dB]
2403,94	105,3	-9,04	96,3	1000	-10,0	95,3	86,3	114,0	94,0	-7,7

Channel center										
Frequency [MHz]	Reading Level PK [dB $\mu$ V]	Corr. Duty Cycle [dB]	Level AV [dB $\mu$ V] *)	Band-width [kHz]	Correct. Factor [dB]	Corrected Level PK [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit PK [dB $\mu$ V/m]	Limit AV [dB $\mu$ V/m]	Delta [dB]
2440,00	106,9	-9,04	97,9	1000	-10,1	96,8	87,8	114,0	94,0	-6,2

Channel high										
Frequency [MHz]	Reading Level PK [dB $\mu$ V]	Corr. Duty Cycle [dB]	Level AV [dB $\mu$ V] *)	Band-width [kHz]	Correct. Factor [dB]	Corrected Level PK [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit PK [dB $\mu$ V/m]	Limit AV [dB $\mu$ V/m]	Delta [dB]
2479,00	108,9	-9,04	99,9	1000	-10,1	98,8	89,8	114,0	94,0	-4,2

Average-Limit according to FCC Subpart 15.249(a) for fundamental and harmonics

Frequency (MHz)	Fieldstrength of fundamental		Fieldstrength of harmonics	
	(mV/m)	dB ( $\mu$ V/m)	( $\mu$ V/m)	dB ( $\mu$ V/m)
902-928	50	94	500	54
<b>2400-2483.5</b>	<b>50</b>	<b>94</b>	<b>500</b>	<b>54</b>
5725-5875	50	94	500	54

Peak-Limit according to FCC Subpart 15.249(a), Subpart 15.249(e) for fundamental and harmonics

Frequency (MHz)	Fieldstrength of fundamental		Fieldstrength of harmonics	
	(mV/m)	dB ( $\mu$ V/m)	( $\mu$ V/m)	dB ( $\mu$ V/m)
902-928	500	114	5000	74
<b>2400-2483.5</b>	<b>500</b>	<b>114</b>	<b>5000</b>	<b>74</b>
5725-5875	500	114	5000	74

\*) Average values were calculated from the subtraction of peak values minus correction duty cycle factor.

The requirements are **FULFILLED**.

Remarks:

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FCC ID: PWPGR-EASY-2400

### 5.3 Radiated emissions (electric field) 9 kHz – 40 GHz

For test instruments and accessories used see section 6 Part **SER1**, **SER 2** and **SER 3**.

#### 5.3.1 Description of the test location

Test location: OATS1  
Anechoic Chamber A2

Test distance: 3 metres

#### 5.3.2 Photo documentation of the test set-up



FCC ID: PWPGR-EASY-2400



FCC ID: PWPGR-EASY-2400



**FCC ID: PWPGTR-EASY-2400****5.3.3 Description of Measurement**

Radiated spurious emissions from the EuT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2003. The Interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna was positioned 3, 10 or 30 meters horizontally from the EuT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarization's and the EuT are rotated 360 degrees.

The final level, expressed in dB $\mu$ V/m, is arrived by taking the reading from the EMI receiver (Level dB $\mu$ V) and adding the correction factors and cable loss factor (Factor dB) to it. This is done automatically in the EMI receiver, where the correction factors are stored. This result then has the FCC or CISPR limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets at page.

The radiated emissions from the EuT are measured in the frequency range of 1 GHz to maximum frequency as specified in section 15.33, using a tuned receiver (Spectrum Analyser) and appropriate linearly polarized antennas. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2003.

The Interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna was positioned 3 horizontally from the EuT.

Measurement are made in both the horizontal and vertical planes of polarization in a fully anechoic room using a spectrum analyzer with the detector function set to peak and resolution as well as video bandwith set to 1 MHz. All tests are performed at a test-distance of 3 meters. Hand-held or body-worn devices are rotated through three orthogonal axes to determine which attitude and configuration procedure the highest emission relative the limit and therefore shall be used for final testing. During the tests the EUT is rotated all around to find the maximum levels of emissions. The cables and equipment were placed and moved within the range of position likely to find their maximum emissions. When the EuT is larger than the beamwidth of the measuring antenna, the measurement antenna will be moved over the surfaces for the four sides or the test distance will be reduced to demonstrate that emissions were at maximum at the limit distance.

The resolution bandwidth during the measurement is as follows:

30 MHz – 1000 MHz:	ResBW: 120 kHz
1000 MHz – 40000 MHz	ResBW: 1 MHz

FCC ID: PWPGTR-EASY-2400

#### 5.3.4 Test result

##### Testresult in detail: (<1GHz)

Channel low									
Frequency [MHz]	Reading Level QP [dB $\mu$ V]	Reading Level AV [dB $\mu$ V]	Bandwidth [kHz]	Correct. factor [dB]	Corrected Level QP [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]	
0,009-0,15			0,2		< 30				
0,15-30			9		< 30				
30-1000			120		< 30				

Channel center									
Frequency [MHz]	Reading Level QP [dB $\mu$ V]	Reading Level AV [dB $\mu$ V]	Bandwidth [kHz]	Correct. factor [dB]	Corrected Level QP [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]	
0,009-0,15			0,2		< 30				
0,15-30			9		< 30				
30-1000			120		< 30				

Channel high									
Frequency [MHz]	Reading Level QP [dB $\mu$ V]	Reading Level AV [dB $\mu$ V]	Bandwidth [kHz]	Correct. factor [dB]	Corrected Level QP [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]	
0,009-0,15			0,2		< 30				
0,15-30			9		< 30				
30-1000			120		< 30				

FCC ID: PWPGTR-EASY-2400

Testresult in detail:(>1GHz)

Corrected field strength of fundamental wave as reference for radiated emissions:

86,3 dB $\mu$ V/m

Channel low										
Frequency [MHz]	Reading Level PK [dB $\mu$ V]	Corr. Duty Cycle [dB]	Level AV [dB $\mu$ V] *)	Band-width [kHz]	Correct. Factor [dB]	Corrected Level PK [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit PK [dB $\mu$ V/m]	Limit AV [dB $\mu$ V/m]	Delta [dB]
1198	67,8	-9,04	58,76	1000	-14,2	53,6	44,56	74,0	54,0	-9,44
2728	56,5	-9,04	47,46	1000	-9,3	47,2	38,16	74,0	54,0	-15,84
3610	57,0	-9,04	47,96	1000	-8,5	48,5	39,46	74,0	54,0	-14,54
4800	59,8	-9,04	50,76	1000	0,6	60,4	51,36	74,0	54,0	-2,64

Corrected field strength of fundamental wave as reference for radiated emissions:

87,8 dB $\mu$ V/m

Channel center										
Frequency [MHz]	Reading Level PK [dB $\mu$ V]	Corr. Duty Cycle [dB]	Level AV [dB $\mu$ V] *)	Band-width [kHz]	Correct. Factor [dB]	Corrected Level PK [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit PK [dB $\mu$ V/m]	Limit AV [dB $\mu$ V/m]	Delta [dB]
1216	71,4	-9,04	62,36	1000	-14,3	57,1	48,06	74,0	54,0	-5,94
2728	57,3	-9,04	48,26	1000	-9,3	48,0	38,96	74,0	54,0	-15,04
3664	56,2	-9,04	47,16	1000	-8,4	47,8	38,76	74,0	54,0	-15,24
4880	60,5	-9,04	51,46	1000	0,8	61,3	52,26	74,0	54,0	-1,74

Corrected field strength of fundamental wave as reference for radiated emissions:

89,9 dB $\mu$ V/m

Channel high										
Frequency [MHz]	Reading Level PK [dB $\mu$ V]	Corr. Duty Cycle [dB]	Level AV [dB $\mu$ V] *)	Band-width [kHz]	Correct. Factor [dB]	Corrected Level PK [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit PK [dB $\mu$ V/m]	Limit AV [dB $\mu$ V/m]	Delta [dB]
1240	69,9	-9,04	60,86	1000	-14,4	55,5	46,46	74,0	54,0	-7,54
2728	56,9	-9,04	47,86	1000	-9,3	47,6	38,56	74,0	54,0	-15,44
4960	53,7	-9,04	44,66	1000	1,0	54,7	45,66	74,0	54,0	-8,34

\*) Average values were calculated from the subtraction of peak values minus correction duty cycle factor.

**FCC ID: PWPGTR-EASY-2400**

Average-Limit according to FCC Subpart 15.249(a)

Frequency (MHz)	Fieldstrength of fundamental		Fieldstrength of harmonics	
	(mV/m)	dB ( $\mu$ V/m)	( $\mu$ V/m)	dB ( $\mu$ V/m)
902-928	50	94	500	54
<b>2400-2483.5</b>	<b>50</b>	<b>94</b>	<b>500</b>	<b>54</b>
5725-5875	50	94	500	54

Peak-Limit according to FCC Subpart 15.249(a), Subpart 15.249(e)

Frequency (MHz)	Fieldstrength of fundamental		Fieldstrength of harmonics	
	(mV/m)	dB ( $\mu$ V/m)	( $\mu$ V/m)	dB ( $\mu$ V/m)
902-928	500	114	5000	74
<b>2400-2483.5</b>	<b>500</b>	<b>114</b>	<b>5000</b>	<b>74</b>
5725-5875	500	114	5000	74

Average-Limit according to FCC Subpart 15.249(d) for spurious emissions outside of the specified frequency band:

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

**Channel low:**

Frequency [MHz]	50dB below of the fundamental [ $\text{dB}\mu\text{V/m}$ ]	15.209 Limits [ $\text{dB}\mu\text{V/m}$ ]	General Radiated Limits [ $\text{dB}\mu\text{V/m}$ ]
30-88	<b>45,3</b>	40	<b>45,3</b>
88-216	<b>45,3</b>	43,5	<b>45,3</b>
216-960	45,3	<b>46</b>	<b>46</b>
Above 960	45,3	<b>54</b>	<b>54</b>

**Channel center:**

Frequency [MHz]	50dB below of the fundamental [ $\text{dB}\mu\text{V/m}$ ]	15.209 Limits [ $\text{dB}\mu\text{V/m}$ ]	General Radiated Limits [ $\text{dB}\mu\text{V/m}$ ]
30-88	<b>46,8</b>	40	<b>46,8</b>
88-216	<b>46,8</b>	43,5	<b>46,8</b>
216-960	<b>46,8</b>	46	<b>46,8</b>
Above 960	46,8	<b>54</b>	<b>54</b>

**Channel high:**

Frequency [MHz]	50dB below of the fundamental [ $\text{dB}\mu\text{V/m}$ ]	15.209 Limits [ $\text{dB}\mu\text{V/m}$ ]	General Radiated Limits [ $\text{dB}\mu\text{V/m}$ ]
30-88	<b>48,8</b>	40	<b>48,8</b>
88-216	<b>48,8</b>	43,5	<b>48,8</b>
216-960	<b>48,8</b>	46	<b>48,8</b>
Above 960	48,8	<b>54</b>	<b>54</b>

FCC ID: PWPGTR-EASY-2400

**Restricted bands of operation:**

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209

MHz	MHz	GHz
25.5 – 25.67	960 – 1240	4.5 – 5.15
37.5 – 38.25	1300 – 1427	5.35 – 5.46
73 – 74.6	1435 – 1626.5	7.25 – 7.75
74.8 – 75.2	1645.5 – 1646.5	8.025 – 8.5
108 – 121.94	1660 – 1710	9.0 – 9.2
123 – 138	1718.8 – 1722.2	9.3 – 9.5
149.9 – 150.05	2200 – 2300	10.6 – 12.7
156.52475 – 156.52525	2310 – 2390	13.25 – 13.4
156.7 – 156.9	2483.5 – 2500	14.47 – 14.5
162.0125 – 167.17	2655 – 2900	15.35 – 16.2
167.72 – 173.2	3260 – 3267	17.7 – 21.4
240 – 285	3332 – 3339	22.01 – 23.12
322 – 335.4	3345.8 – 3358	23.6 – 24.0
399.9 – 410	3600 – 4400	31.2 – 31.8
608 – 614		36.43 – 36.5

The requirements are **FULFILLED**.

**Remarks:** During the test, the Eut was set into continuous transmitting mode.

The measurement was performed up to the 10<sup>th</sup> harmonic (25000MHz).

FCC ID: PWPGR-EASY-2400

## 5.4 Emission Bandwidth

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

### 5.4.1 Description of the test location

Test location: AREA4

### 5.4.2 Photo documentation of the test set-up



### 5.4.3 Description of Measurement

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio of -20 dB. The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or the first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.

The resolution bandwidth of measuring instrument was set to a value as shown in the following table below according to ANSI C63.4-2003.

Fundamental frequency	Minimum resolution bandwidth
9 kHz to 30 MHz	1kHz
30 to 1000 MHz	10 kHz
1000 MHz to 40 GHz	30 kHz

### 5.4.4 Test result

Channel low			
Channel Frequency [MHz]	Lower Frequency edge [MHz]	Higher frequency edge [MHz]	20 dB Bandwidth [MHz]
2404,00	2403,62	2404,60	0,980

FCC ID: PWPGTR-EASY-2400

Channel center			
Channel Frequency [MHz]	Lower Frequency edge [MHz]	Higher frequency edge [MHz]	20 dB Bandwidth [MHz]
2440,02	2439,52	2440,62	1,100

Channel high			
Channel Frequency [MHz]	Lower Frequency edge [MHz]	Higher frequency edge [MHz]	20 dB Bandwidth [MHz]
2479,00	2478,30	2479,66	1,360

Emission bandwidth limit according to FCC Subpart 15.215(c)

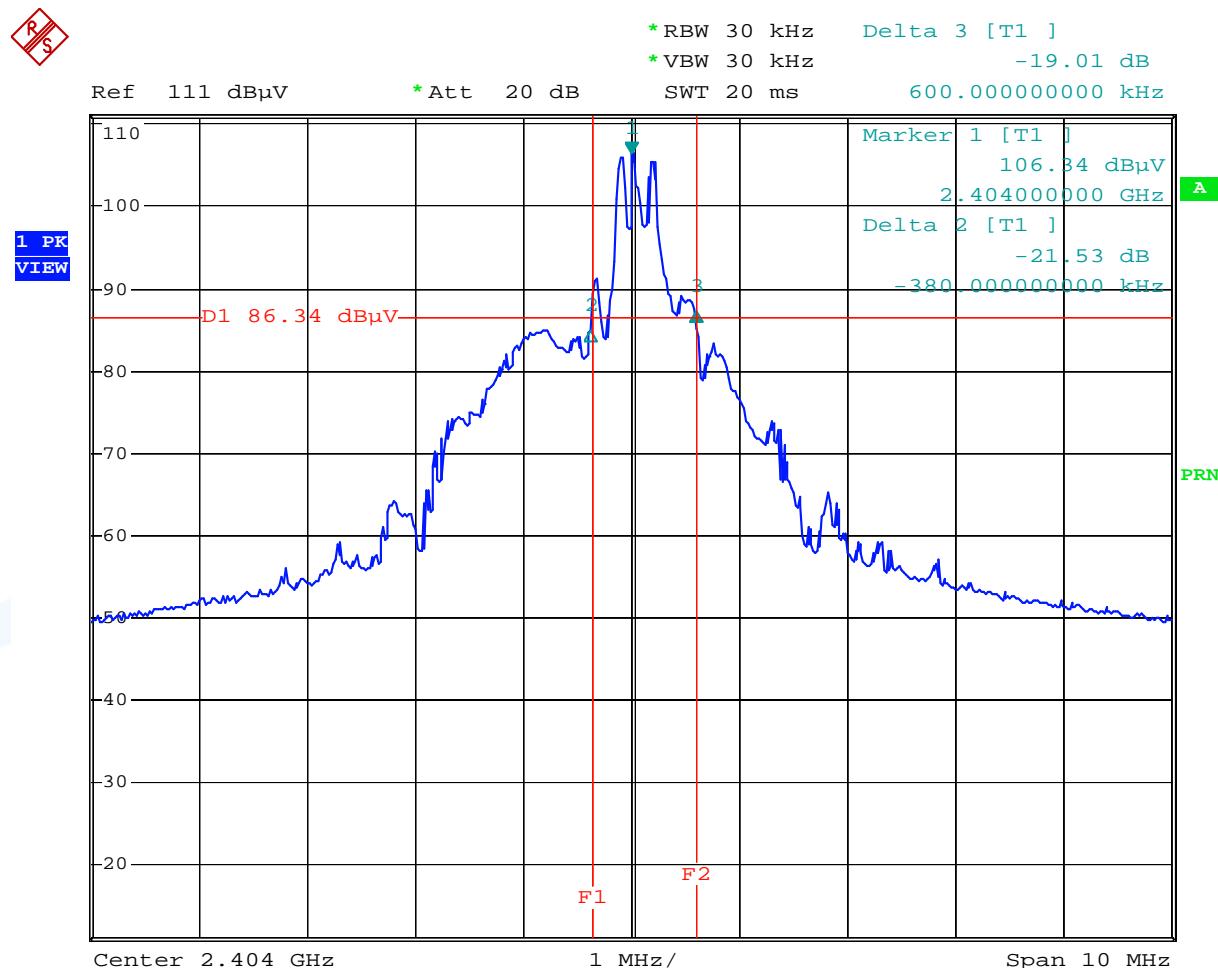
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission is contained within the frequency band designated in the rule section under which the equipment is operated.

**Remarks:** For detailed test result please refer to following test protocol.

FCC ID: PWPGR-EASY-2400

5.4.5 Test protocol

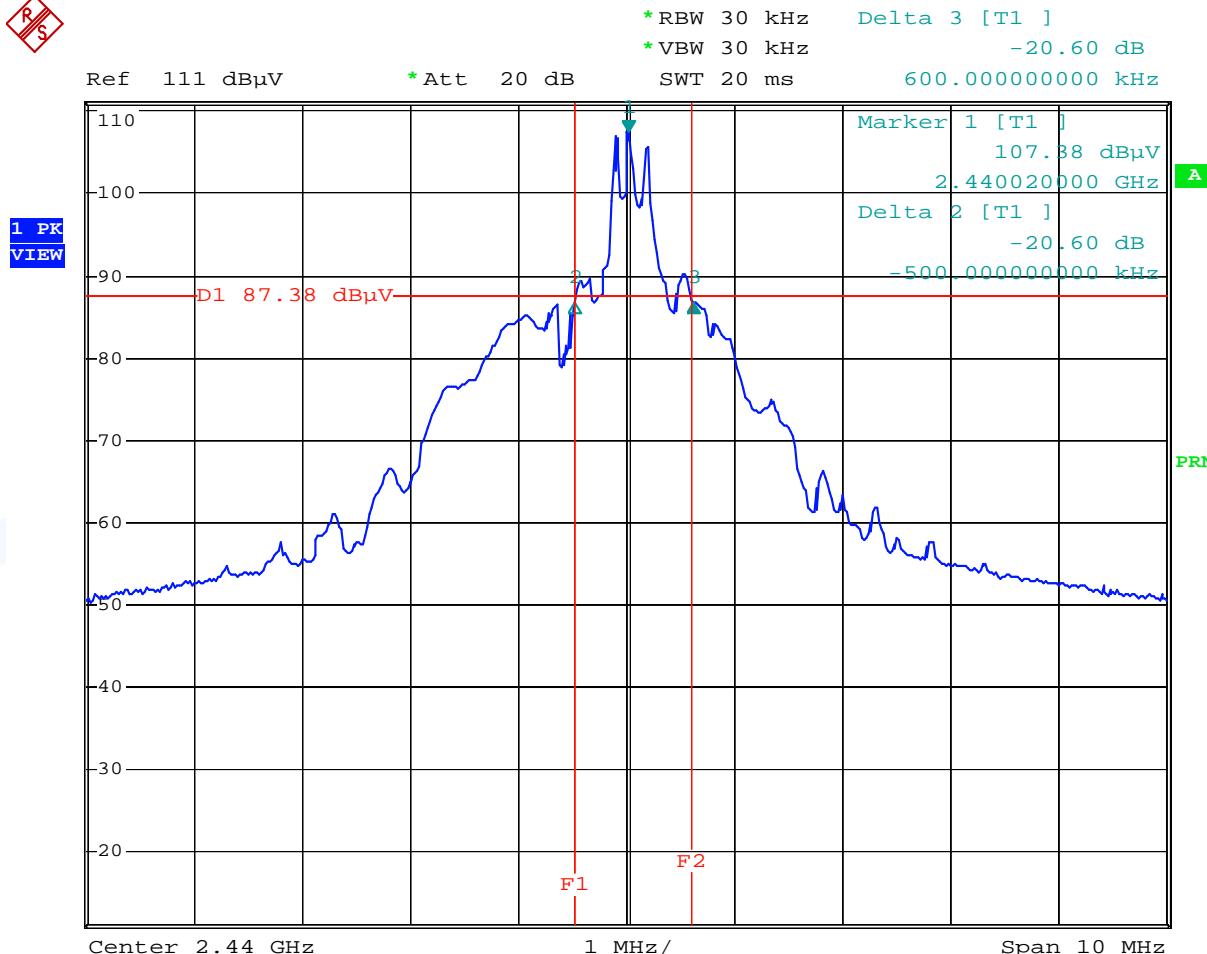
**Emission Bandwidth  
Channel low**



Date: 10.OCT.2005 11:20:49

FCC ID: PWPGTR-EASY-2400

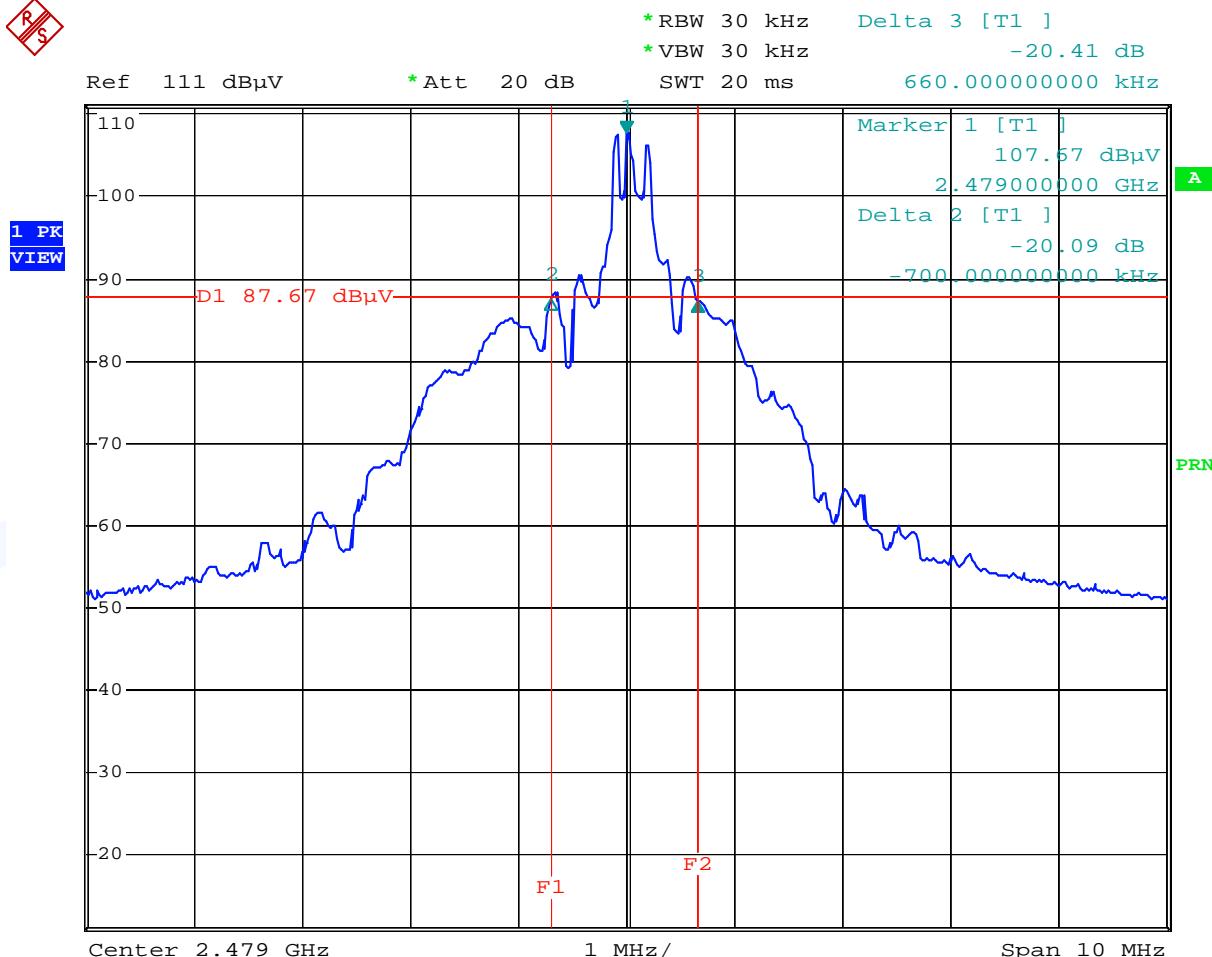
**Emission Bandwidth  
Channel center**



Date: 10.OCT.2005 11:18:11

FCC ID: PWPGTR-EASY-2400

**Emission Bandwidth  
Channel high**



Date: 10.OCT.2005 11:31:12

FCC ID: PWPGTR-EASY-2400

## 5.5 Band edge test

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

### 5.5.1 Description of the test location

Test location: AREA4

### 5.5.2 Photo documentation of the test set-up



### 5.5.3 Description of Measurement

The EuT was connected to the spectrum analyzer with a suitable attenuator. The span of the spectrum analyzer was set wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation. The highest amplitude appearing on spectral display was measured and it was set as the reference level for the emission mask.

It was allowed the trace to stabilize and after then it was set the emission mask on the reference level to show the compliance with the bandedge requirements.

Further settings on the spectrum analyzer:

RBW:  $\geq 1\%$  of the span

VBW:  $\geq$  RBW

Sweep: Auto

Detector function: Peak

### 5.5.4 Test result

Frequency [MHz]	Peak Power Output [dB $\mu$ V]	Spurious emission read value [dB $\mu$ V]	Result of Band edge [dBc]	Band edge LIMIT [dBc]
< 2400	106,23	< 52	> 54,23	50
> 2483,5	107,73	< 52	> 55,73	50

**FCC ID: PWPGR-EASY-2400**

Peak-Limit according to FCC Subpart 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.

The requirements are **FULFILLED**.

**Remarks:** For detailed test result please refer to following test protocol.

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mikes

FCC ID: PWPGTR-EASY-2400

5.5.5 Test protocol

Lower band edge



Date: 10.OCT.2005 11:52:22

**FCC ID: PWPGTR-EASY-2400**

## Higher band edge



Date: 10.OCT.2005 11:46:36

FCC ID: PWPGTR-EASY-2400

## 5.6 Correction for Pulse Operation (Duty Cycle)

For test instruments and accessories used see section 6 Part DC.

### 5.6.1 Description of the test location

Test location: AREA4

### 5.6.2 Photo documentation of the test set-up



### 5.6.3 Description of Measurement

The Duty cycle factor, expressed in dB, is arrived by taking the following formula:

$$KE = 20 \log [(t_{iB} * p) / T_w]$$

KE: pulse operation correction factor [dB]  
t<sub>w</sub> pulse duration for one complete pulse track [msec]  
t<sub>iB</sub> pulse duration for one pulse [ $\mu$ sec]  
T<sub>w</sub> a period of the pulse track [msec]  
p number of pulses in one train

FCC ID: PWPGR-EASY-2400

**5.6.4 Test result**

$t_{iw}$ [ $\mu$ sec]	$T_w$ [msec]	$t_{iB}$ [msec]	p	$K_E$ [dB / %]
	3,20	1,13	1	-9,04 / 35,31

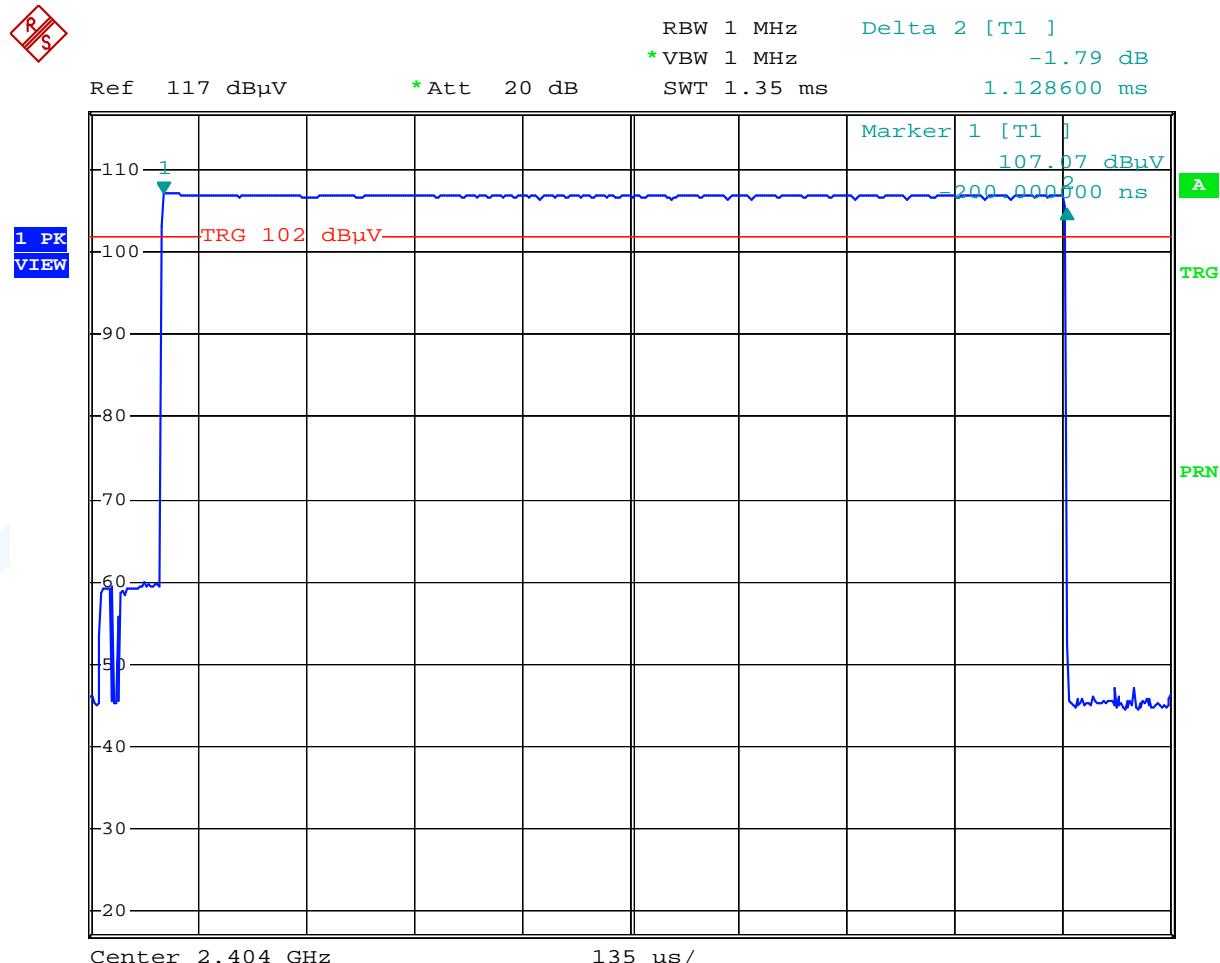
**Remarks:** This duty cycle is the worst case and was caused by the test modulation. In normal use the duty cycle in percent will be smaller.

For detailed results, please see the test protocol below.

FCC ID: PWPGTR-EASY-2400

5.6.5 Test protocol

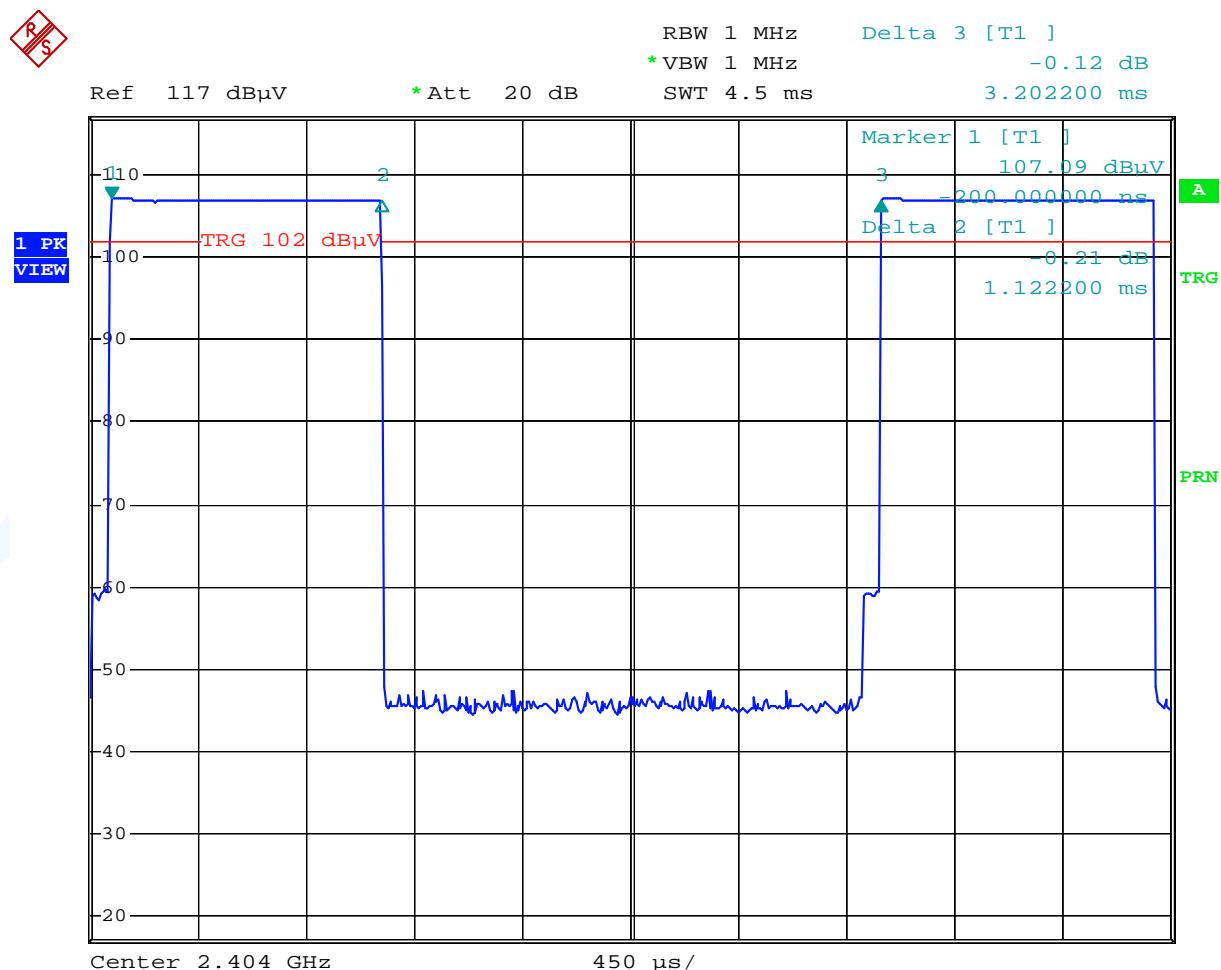
**Correction for Pulse Operation (Duty Cycle)**  
FCC Part 15 Subpart 15.35(c)



Date: 10.OCT.2005 13:30:48

**FCC ID: PWPGTR-EASY-2400**

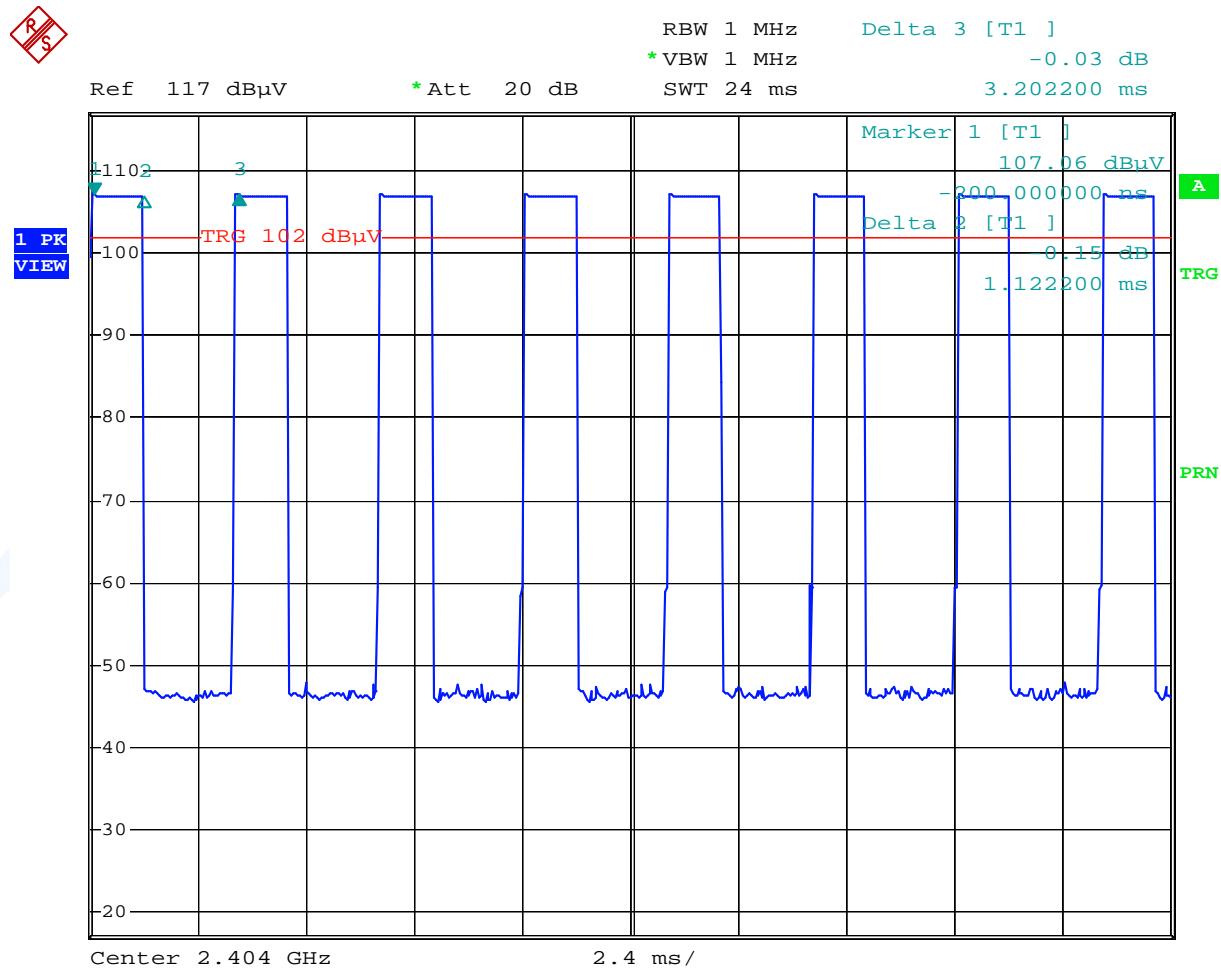
## Correction for Pulse Operation (Duty Cycle) FCC Part 15 Subpart 15.35(c)



Date: 10.OCT.2005 13:40:17

**FCC ID: PWPGTR-EASY-2400**

## Correction for Pulse Operation (Duty Cycle) FCC Part 15 Subpart 15.35(c)



Date: 10.OCT.2005 13:42:01

**FCC ID: PWPGR-EASY-2400**

## **5.7 Antenna application**

### **5.7.1 Antenna requirements**

The EUT's antenna is met the requirement of FCC Part 15 C section 15.203 and 15.204

### **5.7.2 Result**

The EUT used a dipole antenna and is connected to the PCB via SMA reverse connector. The antenna gain is 0 dBi and no other antenna than that furnished by the responsible party will be used with the device.  
In use with the axle measurement computer Easy and GTR the complete module will be built in a case.

FCC ID: PWPGTR-EASY-2400

## 5.8 Receiver conducted disturbances 0.15 - 30 MHz

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

### 5.8.1 Description of the test location

Test location:

### 5.8.2 Photo documentation of the test set-up

### 5.8.3 Description of Measurement

The final level, expressed in dB $\mu$ V, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the FCC Limit or to the CISPR limit, which is equivalent to the Australian AS 3548 limit.

To convert between dB $\mu$ V and  $\mu$ V, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EuT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection, and a Line Impedance Stabilization Network (LISN), with  $50\Omega/50 \mu\text{H}$  (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeter's above the floor and is positioned 40 centimeter's from the vertical ground plane (wall) of the screen room. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are remeasured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

### 5.8.4 Test result

Frequency range:

Min. limit margin:

**Remarks:** The measurement is not applicable because the EuT is batterie powered.

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**FCC ID: PWPGTR-EASY-2400**

## **5.9 Receiver radiated emissions (electric field) 9 kHz - 40 GHz**

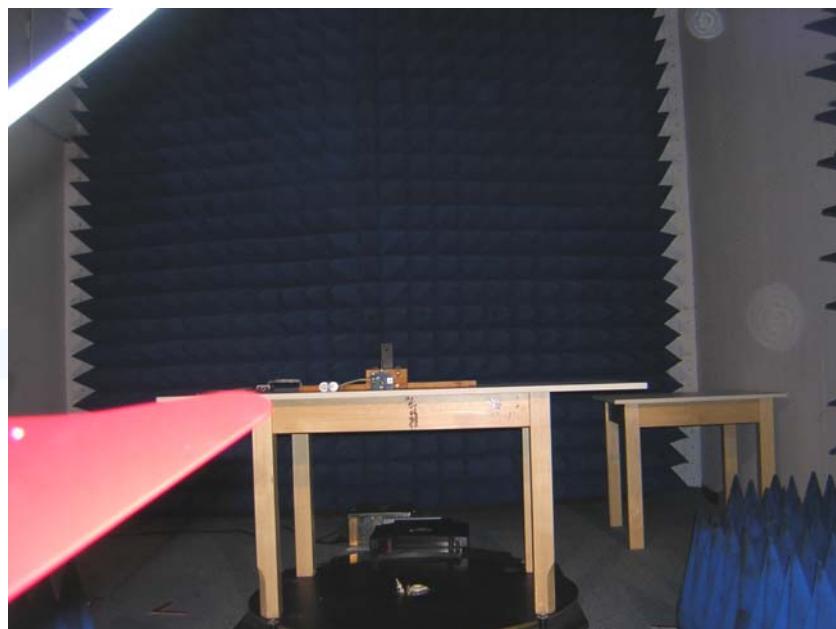
For test instruments and accessories used see section 6 Part **SER1**, **SER 2** and **SER 3**.

### **5.9.1 Description of the test location**

Test location: OATS1  
Anechoic Chamber A2

Test distance: 3 metres

### **5.9.2 Photo documentation of the test set-up**



FCC ID: PWPGR-EASY-2400



FCC ID: PWPGR-EASY-2400



FCC ID: PWPGTR-EASY-2400

### 5.9.3 Test result

#### Testresult in detail: (<1GHz)

Channel low									
Frequency [MHz]	Reading Level QP [dB $\mu$ V]	Reading Level AV [dB $\mu$ V]	Bandwidth [kHz]	Correct. factor [dB]	Corrected Level QP [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]	
0,009-0,15			0,2		< 30				
0,15-30			9		< 30				
30-1000			120		< 30				

Channel center									
Frequency [MHz]	Reading Level QP [dB $\mu$ V]	Reading Level AV [dB $\mu$ V]	Bandwidth [kHz]	Correct. factor [dB]	Corrected Level QP [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]	
0,009-0,15			0,2		< 30				
0,15-30			9		< 30				
30-1000			120		< 30				

Channel high									
Frequency [MHz]	Reading Level QP [dB $\mu$ V]	Reading Level AV [dB $\mu$ V]	Bandwidth [kHz]	Correct. factor [dB]	Corrected Level QP [dB $\mu$ V/m]	Corrected Level AV [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]	
0,009-0,15			0,2		< 30				
0,15-30			9		< 30				
30-1000			120		< 30				

FCC ID: PWPGTR-EASY-2400

Test result >1GHz

Channel low						
Frequency [MHz]	Reading Level PK [dB $\mu$ V]	Bandwidth [kHz]	Correct. factor [dB]	Corrected Level PK [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]
1000-13000		1000		< 50		

Channel center						
Frequency [MHz]	Reading Level PK [dB $\mu$ V]	Bandwidth [kHz]	Correct. factor [dB]	Corrected Level PK [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]
1000-13000		1000		< 50		

Channel high						
Frequency [MHz]	Reading Level PK [dB $\mu$ V]	Bandwidth [kHz]	Correct. factor [dB]	Corrected Level PK [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]
1000-13000		1000		< 50		

Limit according to FCC Subpart 15.109(a)

Frequency of emission [MHz]	Field strength Limits [ $\mu$ V/m]	Field strength Limits [dB $\mu$ V/m]
30-88	100	40
88-216	150	44
216-960	200	46
Above 960	500	54

The requirements are **FULFILLED**.

**Remarks:** During the test, the Eut was set into continuous receiving mode.

According to FCC Part 15.33(b), the measurement was performed up to 13000 MHz.

FCC ID: PWPGTR-EASY-2400

## 6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used, in addition to the test accessories, are calibrated and verified regularly.

The calibration intervals and the calibration history will be given out on request.

Test ID	Model / Type	Kind of Equipment	Manufacturer	Equipment No.
CPR 3	AFS4-01000400-10-10P-4 AMF-4F-04001200-15-10P AFS5-12001800-18-10P-6 3117 Sucoflex N-1600-SMA Sucoflex N-2000-SMA	RF Amplifier 1-4 GHz RF Amplifier 4-12 GHz RF Amplifier 12-18 GHz Horn Antenna 1-18 GHz RF Cable RF Cable	PARZICH GMBH PARZICH GMBH PARZICH GMBH EMCO Elektronik GmbH novotronik Signalverarbeitung novotronik Signalverarbeitung	02-02/17-05-003 02-02/17-05-004 02-02/17-05-005 02-02/24-05-009 02-02/50-05-073 02-02/50-05-075
DC	FSP 30	Spectrum Analyzer	Rohde & Schwarz München	02-02/11-05-001
MB	FSP 30	Spectrum Analyzer	Rohde & Schwarz München	02-02/11-05-001
SER 1	ESCS 30 HFH 2 - Z 2	Test Receiver Antenna	Rohde & Schwarz München Rohde & Schwarz München	02-02/03-05-001 02-02/24-05-020
SER 2	ESVS 30 VULB 9168 S10162-B / +11N-50-10-5 / + KK-EF393-21N-16 NW-2000-NB	Test Receiver Trilog-Broadband Antenna RF Cable 33 m RF Cable 20 m RF Cable	Rohde & Schwarz München Schwarzbeck Mess-Elektronik Huber + Suhner Huber + Suhner Huber + Suhner	02-02/03-05-006 02-02/24-05-005 02-02/50-05-031 02-02/50-05-033 02-02/50-05-113
SER 3	AFS4-01000400-10-10P-4 AMF-4F-04001200-15-10P AFS5-12001800-18-10P-6 3117 Sucoflex N-1600-SMA Sucoflex N-2000-SMA	RF Amplifier 1-4 GHz RF Amplifier 4-12 GHz RF Amplifier 12-18 GHz Horn Antenna 1-18 GHz RF Cable RF Cable	PARZICH GMBH PARZICH GMBH PARZICH GMBH EMCO Elektronik GmbH novotronik Signalverarbeitung novotronik Signalverarbeitung	02-02/17-05-003 02-02/17-05-004 02-02/17-05-005 02-02/24-05-009 02-02/50-05-073 02-02/50-05-075