



electronic GmbH

Prüfbericht / Test report

Test-Firm-Registration-Number: 90870

FCC
(Federal Communications Commission)



TESTED
IN GERMANY

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Prüfbericht Nr./
Test report no.: **10/01-0093**

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Note:

The test equipments used at pkm are calibrated by an external DKD-calibration laboratory. Calibration documents are available upon request.

To duplicate parts of this test report needs the written confirmation of the test laboratory.

The test results are based only on the following specified test sample (see 2. EQUIPMENT UNDER TEST).



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1. CLIENT INFORMATION:

Name: EnOcean GmbH
Address: Kolpingring 18a, 82041 Oberhaching, Germany
Name of contact: Mr. Darius Draksas
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E-mail: darius.draksas@enocean.com

2. EQUIPMENT UNDER TEST:

2.1 Identification of the EUT

Equipment: 315 MHz Transceiver Modul
Model: TCM300C / STM300C
Brand name: -/-
Serial no.: 148001000077
Manufacturer: -/-
Country of origin: Germany
Date of receipt of test sample: 27.01.2010
Date of tests performed: 27.01.2010
Power supply: 2.5V - 4.5V DC
Frequency: 315MHz
Type of modulation: 373KA1DAN
Number of channels: 1
Antenna: wire antenna 15cm
Max. ERP: 94.9 dB μ V/m peak, measured at 3m distance from transmitter
74.9 dB μ V/m average, measured at 3m distance from transmitter
Applied standards: FCC Part 15 - Radio Frequency Devices, Subpart C - Intentional Radiators
15.231, Subpart B - Unintentional Radiators for the receiver part

2.2 Additional information about the EUT: During fieldstrength- and bandwidth-tests a 3V Varta CR2032 battery was used as power supply, where for conducted emission a AC DC converter with 115V / 60Hz input and 3V DC output was used.



3. TEST SITE

3.1. Shielded room for conducted emission

Measurement of conducted emission from EUT was made in the shielded chamber (Siemens DC-10GHz) that has been found in compliance with Federal Communications Commissions (FCC) requirements according to ANSI C63.4-2003 on March 04, 2009.

3.2. Semi-anechoic chamber/OATS for radiated emission

Measurement of radiated emissions from EUT was made in the semi-anechoic chamber that has been found in compliance with Federal Communications Commissions (FCC) requirements according to ANSI C63.4-2003 on March 04, 2009.

4. CALIBRATIONS OF MEASURING INSTRUMENTS

All measurements were made with instruments calibrated according to the requests of EN/IEC 17025 according to which the test site is accredited. Measurement of radiated emissions was made with instruments conforming to American National Standard Specification, ANSI C63.4-2003. The calibration of measuring instrument, including any accessories that may affect test results, was performed according to the requests of EN/IEC 17025.

5. DESCRIPTION OF THE TEST CONDITIONS (general)

5.1 Conducted emission measurements

5.1.1 Test site

Measurements were made in shielded chamber as described at 3.1 in this report.

5.1.2 Detector function selection and bandwidth

In conducted emissions measurement CISPR quasi-peak- and average-detector were used.

The bandwidth of the detector of instrument is 10 kHz over the frequency range of 150 kHz to 30 MHz, Conducted emission is detected in CCIR quasi-peak- and average-mode.

5.1.3 Unit of measurement

Test results of conducted emission measurement are reported in dB μ V.

5.1.4 Frequency range to be scanned

For conducted emission measurements, the spectrum in the range of 150 kHz to 30 MHz was investigated.

5.1.5 Test conditions and configuration of EUT

The EUT was configured and operated in all modes of operation so as to find the maximum conducted emission generated from EUT.

The power was furnished with rated (normal) voltage, as specified in the owner's manual of EUT. The EUT was placed on a 80 cm high non metallic table.

Each type of accessory provided by manufacturer or typically used and support equipment were connected to the EUT during measurements as for the typical usage and applicable as nearly as practicable.

5.1.6 Measurement uncertainty

Conducted emission measurements: ± 1.8 dB

The measurement uncertainty describes the overall uncertainty of the given measured value during the operation of the EUT in the above mentioned way.

The measurements uncertainty was calculated in accordance with NAMAS NIS 81: "The treatment of uncertainty in EMC measurement" and "Guide to the Expression of Uncertainty in Measurement (GUM)".

The measurement uncertainty was given with a confidence of 95%.



5.2 Radiated emissions measurements

5.2.1 Test site

Measurements were made in semi-anechoic chamber as described at 3.2 in this report.

5.2.2 Detector function selection and bandwidth

In radiated emissions measurement, field strength meters that have CISPR quasi-peak and average were used.

The bandwidth of the detector of instrument is 200 Hz over the frequency range of 9 kHz to 150 kHz, 10 KHz over the frequency range of 150 kHz to 30 MHz and 120kHz over the frequency range of 30 MHz to 1000 MHz, emissions to be measured are detected in CCIR quasi peak mode.

The bandwidth of the detector of instrument is 1000 KHz for frequencies above 1000 MHz, emissions to be measured are detected in average mode.

5.2.3 Unit of measurement

Test results of radiated emissions measurement are reported in dB(microvolts per meter) at the specific distance. Using the unit of dB μ V on the test instrument, the indication unit can be converted to field strength unit of μ V/m as following method for frequencies 30 MHz – 1000 MHz;

$$F/S = 10^{[(R + CF)/20]}$$

here,

F/S: Field strength in μ V/m

R: Meter reading in dB (μ V)

CF: Correction factor (includes cable loss, antenna factor, field deviation)

5.2.4 Antennas

Measurements were made using a calibrated loop antenna in range of 9 kHz to 30 MHz, a calibrated bilog antenna in range of 30 to 1000 MHz and a calibrated horn antenna in range of 1000 to 6000 MHz to determine the emission characteristics of the EUT. Measurements were also made for both horizontal and vertical polarization.

The horizontal distance between the receiving antenna and the EUT was 3 meter.

5.2.5 Frequency range to be scanned

For radiated emissions measurements, the spectrum in the range of 9kHz to 4000 MHz was investigated.

5.2.6 Test conditions and configuration of EUT

The EUT was configured and operated in all modes of operation so as to find the maximum RF energy generated from EUT.

The power was furnished with rated (normal) voltage, as specified in the owner's manual of EUT. The EUT was placed on a 80 cm high non metallic 1 m diameter table. The turntable containing the system was rotated and the antenna height was varied 4 m(for 9 kHz - 30 MHz: 1m fixed) to find the maximum RF energy generated from EUT.

Each type of accessory provided by manufacturer or typically used and support equipment were connected to the EUT during measurements to the typical usage and applicable as nearly as practicable.

5.2.7 Measurement uncertainty

Radiated emissions measurements, loop antenna: \pm 2.6 dB, bilog antenna: \pm 2.7 dB, horn antenna \pm 2.9dB

The measurement uncertainty describes the overall uncertainty of the given measured value during the operation of the EUT in the above mentioned way.

The measurements uncertainty was calculated in accordance with NAMAS NIS 81: "The treatment of uncertainty in EMC measurement" and "Guide to the Expression of Uncertainty in Measurement (GUM)".

The measurement uncertainty was given with a confidence of 95 %.

6. MEASURING INSTRUMENTS AND SET-UP

6.1 Conducted emission

6.1.1 Test receiver

Rohde & Schwarz, model ESHS-30 (9 kHz – 30 MHz)

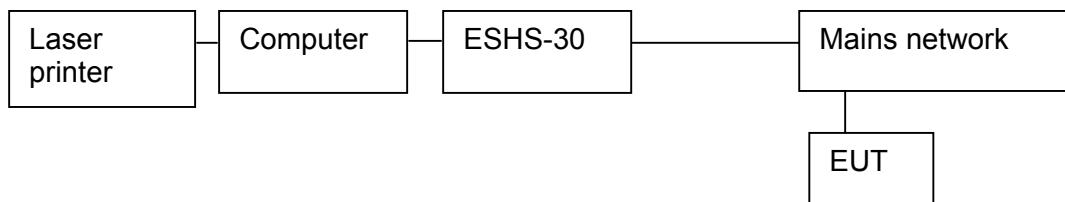
Detector function: quasi peak

IF bandwidth: 10 kHz

6.1.2 Mains network

Rohde & Schwarz, model ESH2-Z5 (9 kHz – 30 MHz)

6.1.3 Measurement setup



6.2 Radiated emission

6.2.1 Test receiver

Rohde & Schwarz, model ESHS-30 (9 kHz – 30 MHz)

Detector function: quasi peak

IF bandwidth: 200Hz/10 kHz

Rohde & Schwarz, model ESVS-30 (20 MHz – 1000 MHz)

Detector function: quasi peak

IF bandwidth: 120kHz

Rohde & Schwarz, model FSMS26 (above 1000MHz)

Schwarzbeck, Preamplifier model BBV 9718 1GHz - 18GHz

Detector function: average

IF bandwidth: 1000kHz

6.2.2 Receiving antenna

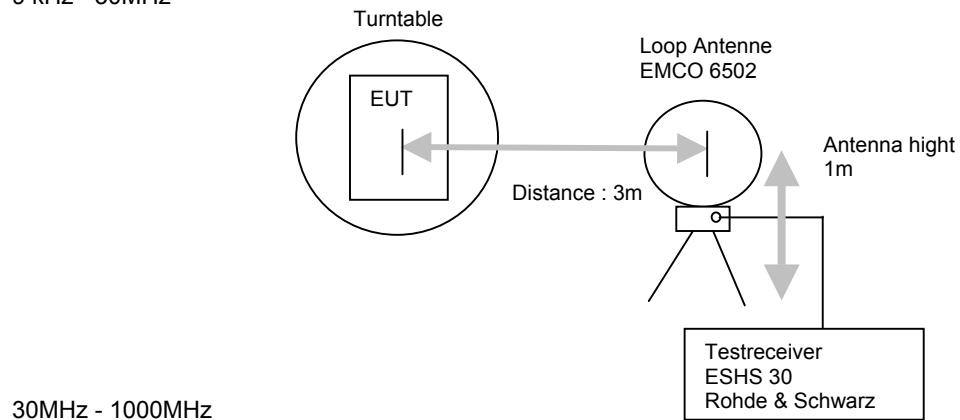
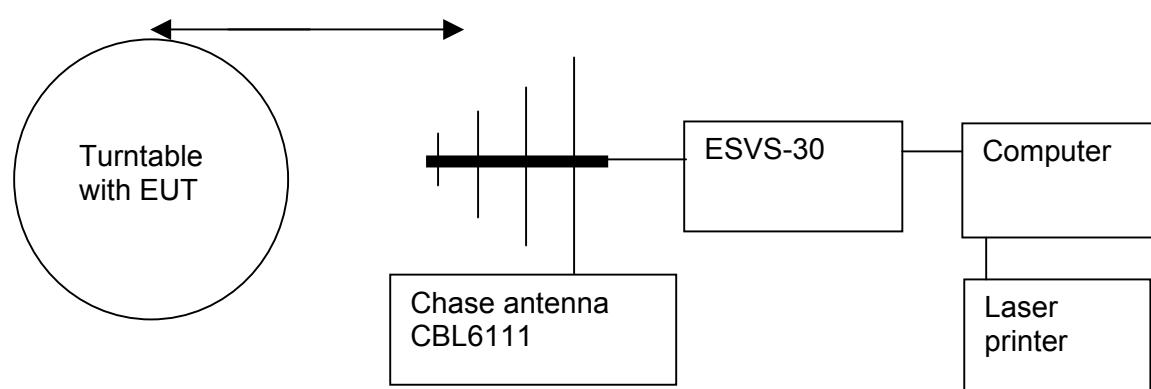
EMCO, model 6502, loop antenna (9kHz - 30MHz)

Chase, model CBL6111: bilog antenna (30 MHz – 1000 MHz)

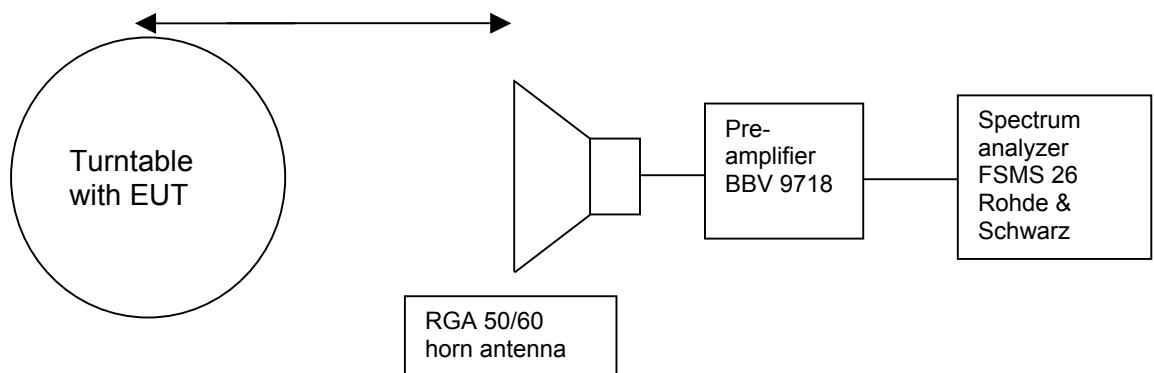
Electro Metric RGA 50/60 horn antenna (above 1000MHz)

6.2.3 Measurement setup

9 kHz - 30MHz

Test distance
3m class

above 1000MHz

Test distance
3m



7. MEASUREMENTS AND RESULTS

7.1 General

The measurement of radiated emissions from EUT was made in the semi-anechoic chamber that has been found in compliance with Federal Communications Commissions (FCC) requirements of clause 2.948 according to ANSI C63.4-2003 on March 04, 2009.

During tests the EUT was placed on a non conductive turntable with a height of 0.8m above the ground plane. The EUT was investigated in all three axis by turning around and changing the antenna height from 1m to 4m (for 9 kHz - 30 MHz: 1m fixed) in horizontal and vertical polarisation to get the maximum emission.

The distance between the EUT and antenna is 3m. The used detectors are Quasi Peak for measurements in the frequency range 9 kHz-1000 MHz with the EMI test receivers ESVS-30. Above 1000 MHz the measurements have been performed with a spectrum analyzer FSMS 26 in Average. The setting of the analyzer during peak measurement was RBW 1MHz with a VBW of 3MHz, during average measurement was RBW 1MHz with a VBW of 10Hz.

7.2 Conducted emission

The EUT had been powered by an external AC/DC adaptor with 3V DC output. Test results for transmitting and receiving see 8.1 in this report.

7.3 Radiated emission (spurious)

During tests the EUT was supplied with 3V DC by an battery to enable continuous transmission. The highest frequency generated in the EUT is 315MHz, therefor the frequency range up to 4000MHz has been investigated (section 15.33 (a)(1)). Test results see 8.2, 8.3 and 8.4 in this report.

The EUT complied with the requirements of section 15.209.

7.4 Switch off time for manually and automatically activated transmitter

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

A transmitter activated automatically shall cease transmission within 5 seconds after activation.

Manufacturer's attestation: The EUT can be activated manually or automatically and the requirements above are fulfilled inherently. The transmitter sends only a short packet which lasts for only a few tens of milliseconds. Thus, it deactivates itself within the 5 second limit.

The EUT complied with the requirements of section 15.231(a)(1)/(2)

7.5 Radiated emission from intentional radiator

The measurement of the intended radiation of the EUT is measured in Peak at a distance of 3m and the Average value is calculated using following formula:

$$\text{fieldstrength (average)} = \text{fieldstrength (peak)} + 20 \times \log \frac{\text{duty cycle [%]}}{100}$$

Calculation see 8.5 in this report.

Calculated average fieldstrength in 3m: 74.9dB μ V/m (5559 μ V/m)
the limit for 315MHz transmitting frequency is 75.6dB μ V/m (6026 μ V/m)

The EUT complied with the requirements of section 15.231(b)

7.6 Bandwidth of the emission

The bandwidth of the emitted signal shall be less than 0.25% of the center frequency for a operation frequency above 70MHz and below 900MHz. With a center frequency of 315MHz, the bandwidth shall be less than 0.787MHz (-20dB from carrier).

With a measured occupied bandwidth of 0.373MHz (test results see 8.6 in this report), the EUT complied with the requirements of section 15.231(c).



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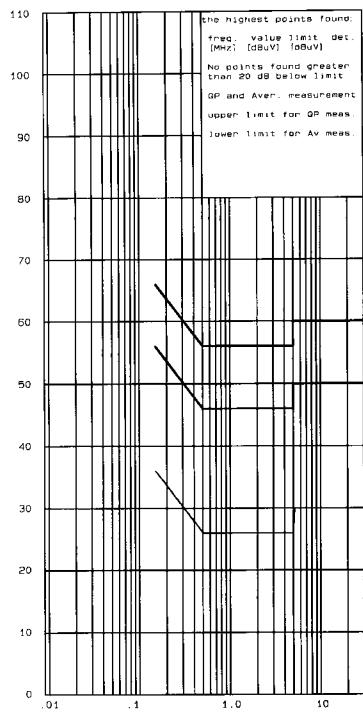
7.7 Radiated emission (spurious) of receiver

During tests the EUT was supplied with 3.0V DC by an battery to enable continuous reception. The highest frequency generated in the EUT is 315MHz, therefor the frequency range up to 4000MHz has been investigated (section 15.33 (a)(1)). Test results see 8.2 and 8.7 in this report.

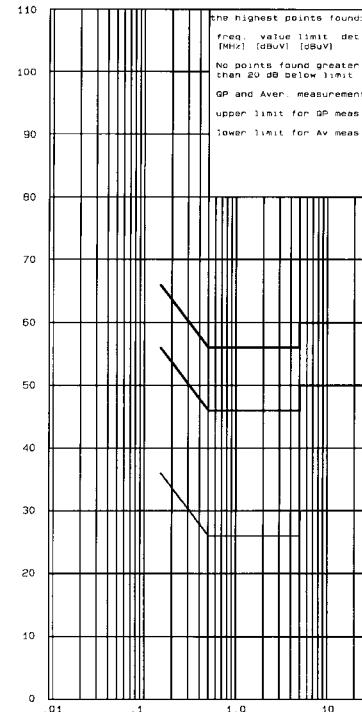
The EUT complied with the requirements of section 15.109(a).

8. TEST DATA

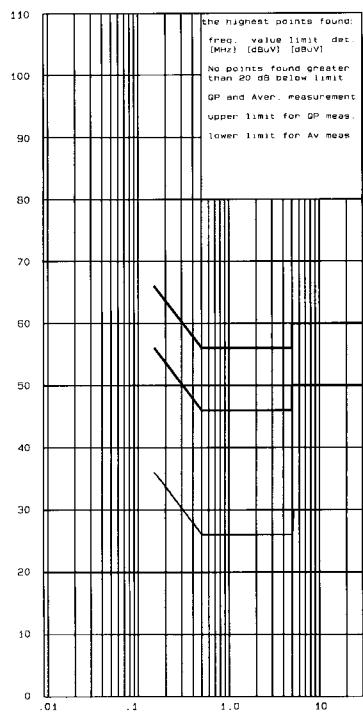
8.1. Conducted emission in the frequency range 150 KHz - 30 MHz



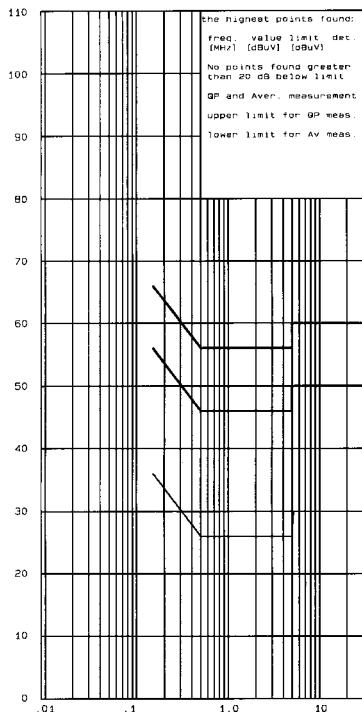
Ref.-No.: 10/01-0093
Product: Trans.-/Rec.-System
Sample: 01
Date: 18 Mar 2010
Operator: B1
Test equipment:
Rohde & Schwarz ESHS 30
Rohde & Schwarz ESH 2-Z5
Connected sets:
Host Adaptor: 3V/DC
Operating mode:
Transmitting
Tested on N
AFI suppression parts:
* two dB safety margin for type approval recommended
Result: pass [X] fail []
PKM electronic GmbH Frontenhausen



Ref.-No.: 10/01-0093
Product: Trans.-/Rec.-System
Sample: 01
Date: 18 Mar 2010
Operator: B1
Test equipment:
Rohde & Schwarz ESHS 30
Rohde & Schwarz ESH 2-Z5
Connected sets:
Host Adaptor: 3V/DC
Operating mode:
Transmitting
Tested on L1
AFI suppression parts:
* two dB safety margin for type approval recommended
Result: pass [X] fail []
PKM electronic GmbH Frontenhausen



Ref.-No.: 10/01-0093
Product: Trans.-/Rec.-System
Sample: 01
Date: 18 Mar 2010
Operator: B1
Test equipment:
Rohde & Schwarz ESHS 30
Rohde & Schwarz ESH 2-Z5
Connected sets:
Host Adaptor: 3V/DC
Operating mode:
Receiving
Tested on L1
AFI suppression parts:
* two dB safety margin for type approval recommended
Result: pass [X] fail []
PKM electronic GmbH Frontenhausen



Ref.-No.: 10/01-0093
Product: Trans.-/Rec.-System
Sample: 01
Date: 18 Mar 2010
Operator: B1
Test equipment:
Rohde & Schwarz ESHS 30
Rohde & Schwarz ESH 2-Z5
Connected sets:
Host Adaptor: 3V/DC
Operating mode:
Receiving
Tested on N
AFI suppression parts:
* two dB safety margin for type approval recommended
Result: pass [X] fail []
PKM electronic GmbH Frontenhausen

LIST OF INSTRUMENT USED

Test place	Kind of equipment	Type	Manufacturer	pkm-ident no.	Cal. date	Cal. due
Conducted emissions 150 KHz - 30 MHz	EMI test receiver	ESHS-30	Rohde&Schwarz	10571	May 2007	May 2011
	Line impedance stabilisation network	ESH2-Z5	Rohde&Schwarz	10139	Dec. 2007	Dec. 2013



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8.2. Radiated emission in the frequency range 9 kHz - 30 MHz (spurious)

In the frequency range 9kHz - 30MHz no emission was found above the noise floor, that means that all emissions from the EUT in transmitting and receiving mode (corrected to the given measuring distance) are at least 20dB below the specified limits:

Frequency [MHz]	Field strength [μ V/m] limit	Field strength [μ V/m] measured	Measuring distance [m] (reference)
0.009 to 0.490	2400/f[kHz]	<0.3 μ V/m	300
0.490 to 1.705	24000/f[kHz]	<0.8 μ V/m	30
1.705 to 30	30	<0.5 μ V/m	30
16MHz	30	<0.5 μ V/m	30

LIST OF INSTRUMENT USED

Test place	Kind of equipment	Type	Manufacturer	pkm-ident no.	Cal. date	Cal. due
Radiated emissions 9 KHz - 30 MHz	EMI test receiver	ESHS-30	Rohde&Schwarz	10571	May 2007	May 2011
	Loop Antenna	6502	EMCO	10546	April 2005	April 2011
	Turntable	DT 310	Deisel	10774	-/-	-/-

8.3. Radiated emission in the frequency range 30MHz - 1000MHz (spurious)

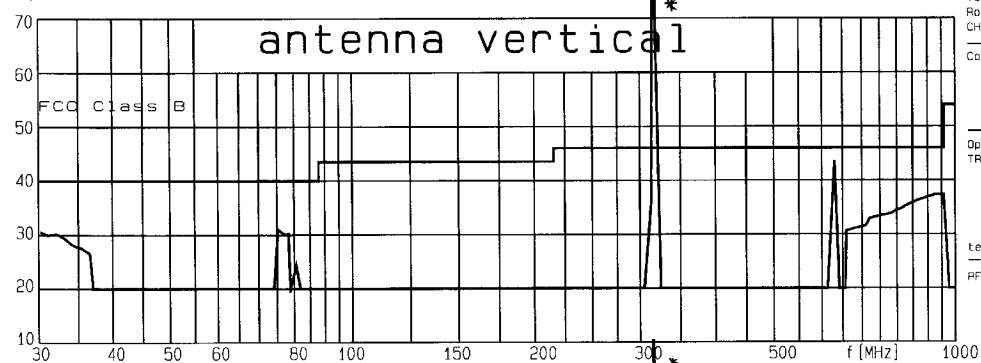


electronic GmbH
Frontenhausen

IT 5/6

Ref.-No.: 10/01-0093
Product: TRANS.-/REC.-SYSTEM
Sample: 01
Date: 27 Jan 2010
Operator: BL

dB μ V/m Interference Radiation 30 MHz - 1000 MHz
acc. FCC Part 15 Subpart B Section 15.109(a) Class B *



Test equipment:
Rohde & Schwarz E5VS
CHASC CBL 6111

Connected sets:

Operating mode:
TRANSMITTING

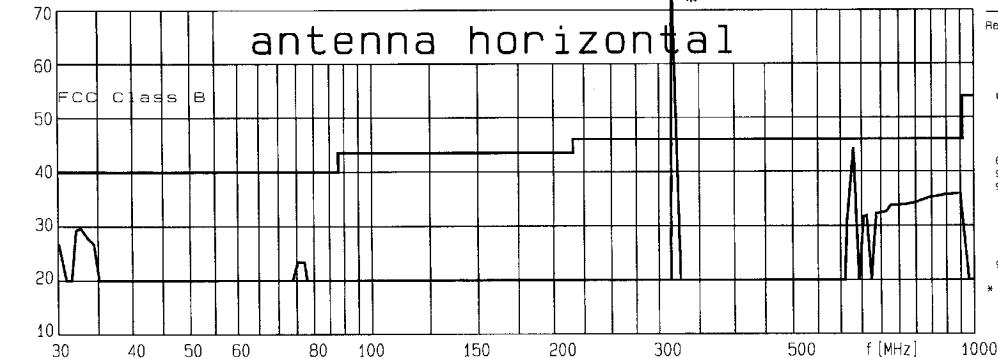
test distance 3m
RFI suppression parts:

Result: pass fail

the highest points found:

freq.	tested limit	pos.
30	46	*
315	46	
630 04	43.67	46 v
955 88	37.36	46 v
937.72	37.35	46 v
925.2	37.28	46 v
315	27.21	46 n
630	24.42	46 n
943.6	25.93	46 n
949	35.9	46 n
919.88	35.82	46 n

* - IF ANY MEANS: EMISSION NOT COUNTED FOR JUDGEMENT



Result: pass fail

Tested frequency [MHz]	Field strength [μ V/m] measured	Field strength [μ V/m] limit	Frequency range [MHz]	Measuring distance [m]	Polarisation
40.66 - 40.7	<10 μ V/m	225	40.66 - 40.7	3	horizontal/vertical
70 - 130	<10 μ V/m	125	70 - 130	3	horizontal/vertical
130 - 174	<10 μ V/m	125 to 375	130 - 174	3	horizontal/vertical
174 - 260	<10 μ V/m	375	174 - 260	3	horizontal/vertical
260 470	<10 μ V/m	375 to 1250	260 470	3	horizontal/vertical
630	427	1250	above 470	3	vertical
945	104	1250	above 470	3	horizontal



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LIST OF INSTRUMENT USED

Test place	Kind of equipment	Type	Manufacturer	pkm-ident no.	Cal. date	Cal. due
Radiated emissions 30 MHz - 1000 MHz	EMI test receiver	ESVS-30	Rohde&Schwarz	10572	October 2007	October 2011
	EMI test antenna	CBL6111	Chase	10022	April 2005	April 2011
	Antenna mast system	AM9104	Schwarzbeck	10099	-/-	-/-
	Turntable	DT 310	Deisel	10774	-/-	-/-

8.4. Radiated emission in the frequency range 1000MHz - 4000MHz (spurious)

Tested frequency [MHz]	Field strength [μ V/m] measured	Field strength [μ V/m] limit	Frequency range [MHz]	Measuring distance [m]	Polarisation
1260	the measured fieldstrength within the frequency range 1000MHz - 4000MHz is less than 100 μ V/m	1250	above 470	3	hor./vertical
1575					hor./vertical
1890					hor./vertical
2205					hor./vertical
2520					hor./vertical
2835					hor./vertical
3150					hor./vertical

LIST OF INSTRUMENT USED

Test place	Kind of equipment	Type	Manufacturer	pkm-ident no.	Cal. date	Cal. due
Interference radiation 1000 MHz – 18 GHz	Spectrum analyzer (100 Hz – 26.5 GHz)	FSMS 26	Rohde & Schwarz	10965	November 2008	November 2012
	Horn antenna (1 GHz – 18 GHz)	RGA-60	Electro Metrics	10273	April 2005	April 2011
	Broadband-Preamplifier 1-18 GHz	BBV9718	Schwarzbeck	10231	October 2007	October 2011
	Antenna mast system	AM9104	Schwarzbeck	10099	-/-	-/-
	Turntable	DT 310	Deisel	10774	-/-	-/-

8.5 Radiated emission from intentional radiator

Tested frequency [MHz]	Field strength [$\text{dB}\mu\text{V}/\text{m}$] measured (peak)	Field strength [$\mu\text{V}/\text{m}$] limit	Frequency range [MHz]	Measuring distance [m]	Polarisation
315	92.6	95.6	260 - 470	3	vertical

The Average value is calculated using following formula:

$$\text{fieldstrength (average)} = \text{fieldstrength (peak)} + 20 \times \log \frac{\text{duty cycle} [\%]}{100}$$

A maximum transmission consist of 3 ASK (OOK) data packets. Each one lasts 2.066 ms with less than 100% on/off duty cycle. Thus, the transmitter is transmitting maximum 2.066 ms during each of the three packets, for a total of 6.2ms for each standard transmission. Because the standard transmission occurs at a period longer than 100 ms, section, 15.35 (c) limits the period (for calculating the average) to 100ms.

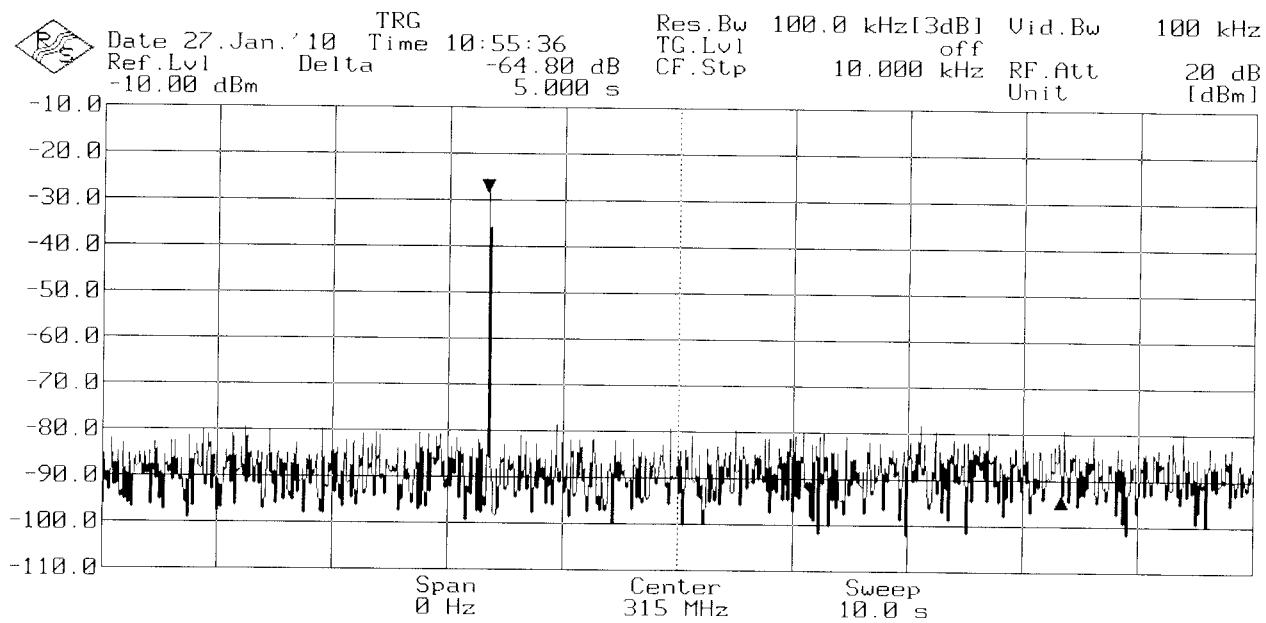
The duty cycle correction factor is $-20 \log (3 * 2.066 \text{ ms} / 100 \text{ ms}) = -24.2 \text{ dB}$ (max 20dB applicable)

$94.9 \text{ dB}\mu\text{V}/\text{m} - 20 \text{ dB} = 74.9 \text{ dB}\mu\text{V}/\text{m}$

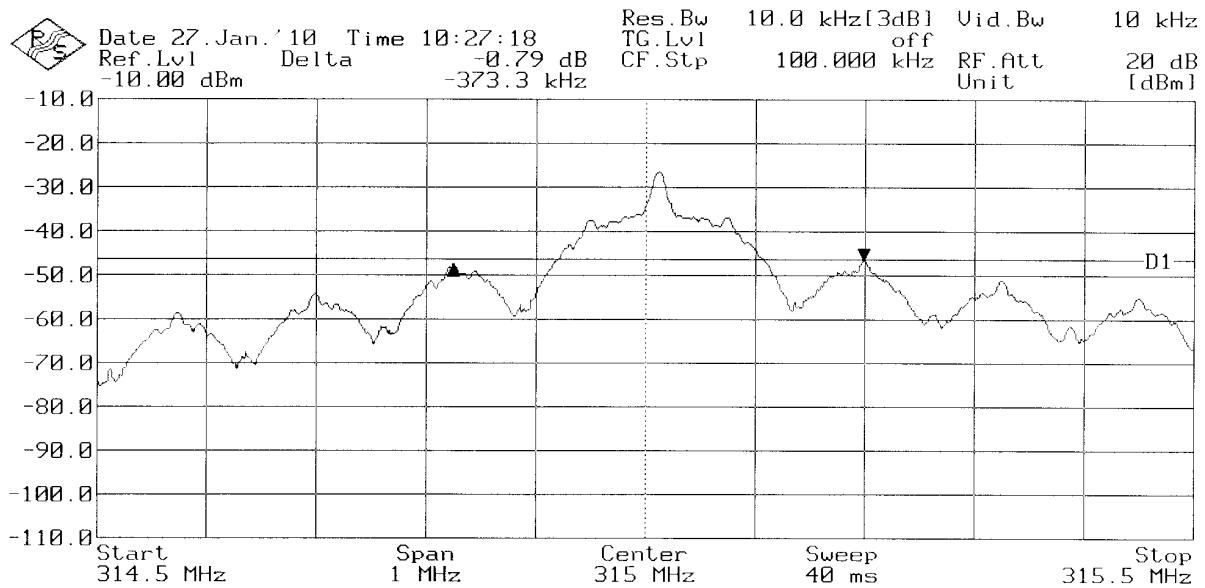
The max. average radiated fundamental power = 74.9 dB μ V (Limit: max 75.6 dB μ V)

LIST OF INSTRUMENT USED

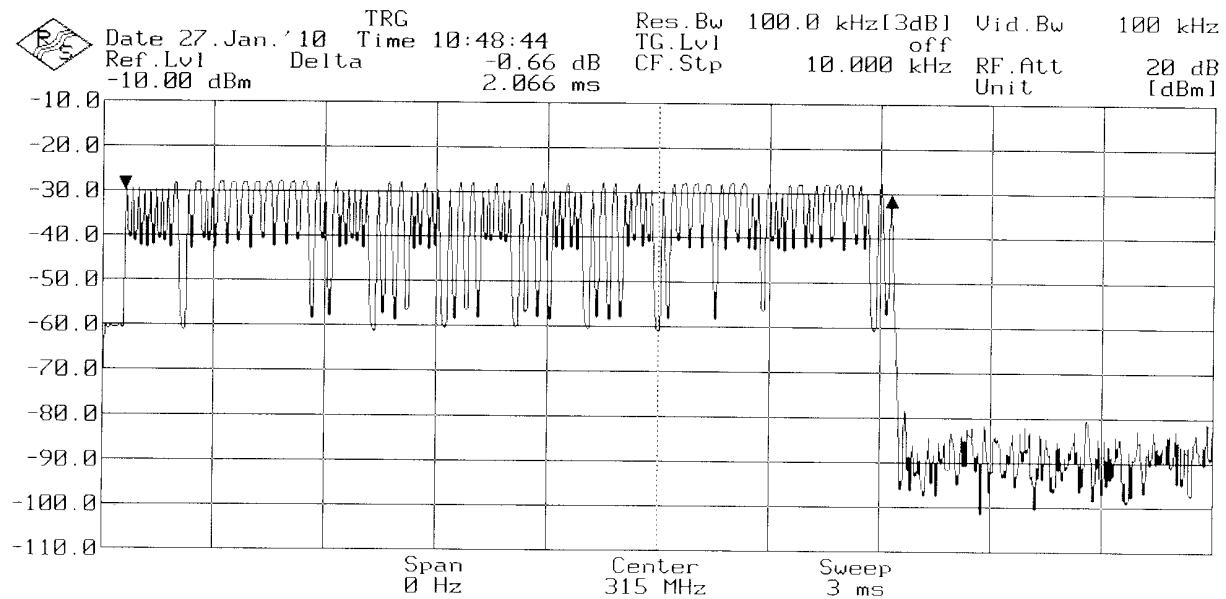
Test place	Kind of equipment	Type	Manufacturer	pkm-ident no.	Cal. date	Cal. due
Radiated emissions 30 MHz - 1000 MHz	EMI test receiver	ESVS-30	Rohde&Schwarz	10572	October 2007	October 2011
	EMI test antenna	CBL6111	Chase	10022	April 2005	April 2011
	Antenna mast system	AM9104	Schwarzbeck	10099	-/-	-/-
	Turntable	DT 310	Deisel	10774	-/-	-/-

8.6 Bandwidth of the emission


Switch off time for manually and automatically activated transmitter: the transmitter cease transmission within 5 seconds after activation



20dB bandwidth measurement: the two marker show the -20dB bandwidth



showing one data packet with 2.066ms and a ~ 50% duty cycle (for calculation of average fieldstrength used 100%)

LIST OF INSTRUMENT USED

Test place	Kind of equipment	Type	Manufacturer	pkm-ident no.	Cal. date	Cal. due
frequency measurements (bandwidth)	EMI test receiver	ESVS-30	Rohde&Schwarz	10572	October 2007	October 2011
	Spectrum analyzer (100 Hz – 26.5 GHz)	FSMS 26	Rohde & Schwarz	10965	November 2008	November 2012
	EMI test antenna	CBL6111	Chase	10022	April 2005	April 2011



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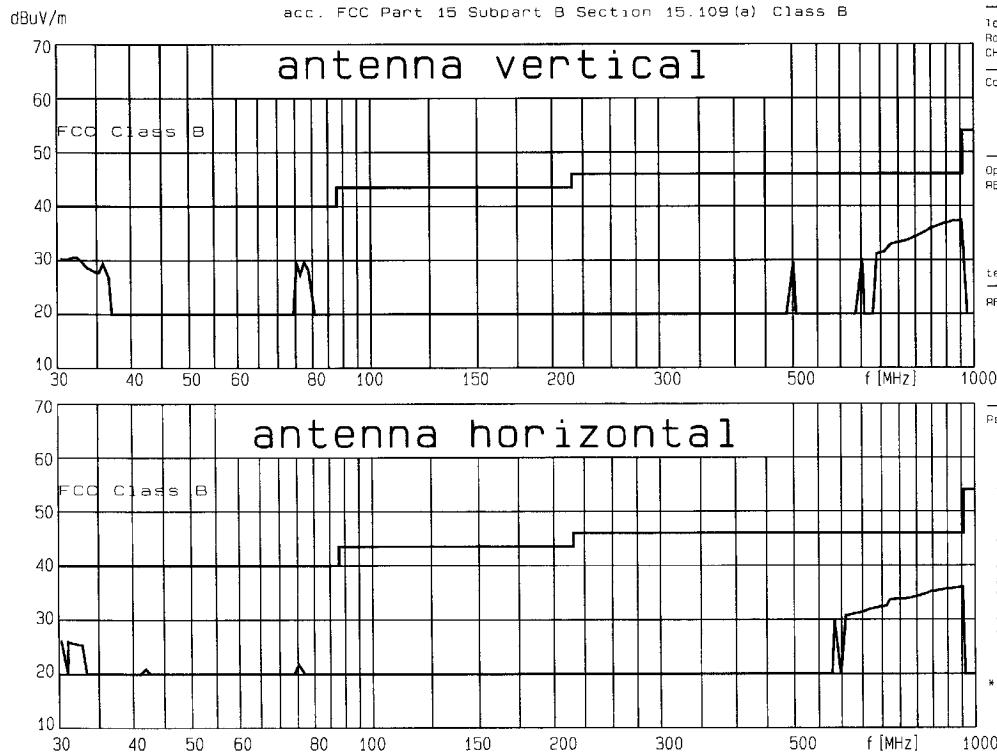
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8.7 Radiated emission from unintentional radiator

pkm electronic GmbH
Frontenhausen

IT 5/6

Interference Radiation 30 MHz - 1000 MHz
acc. FCC Part 15 Subpart B Section 15.109(a) Class B



Tested frequency [MHz]	Field strength [μV/m] measured	Field strength [μV/m] limit	Frequency range [MHz]	Measuring distance [m]	Polarisation
1000-4000	the measured fieldstrength within the frequency range 1000MHz - 4000MHz is less than 100μV/m	1250	above 470	3	hor./vertical hor./vertical hor./vertical hor./vertical hor./vertical hor./vertical hor./vertical hor./vertical

LIST OF INSTRUMENT USED

Test place	Kind of equipment	Type	Manufacturer	pkm-ident no.	Cal. date	Cal. due
Radiated emissions 30 MHz - 1000 MHz	EMI test receiver	ESVS-30	Rohde&Schwarz	10572	October 2007	October 2011
	EMI test antenna	CBL6111	Chase	10022	April 2005	April 2011
	Antenna mast system	AM9104	Schwarzbeck	10099	-/-	-/-
	Turntable	DT 310	Deisel	10774	-/-	-/-
Interference radiation 1000 MHz - 18 GHz	Spectrum analyzer (100 Hz - 26.5 GHz)	FSMS 26	Rohde & Schwarz	10965	November 2008	November 2012
	Horn antenna (1 GHz - 18 GHz)	RGA-60	Electro Metrics	10273	April 2005	April 2011
	Broadband-Preamplifier 1-18 GHz	BBV9718	Schwarzbeck	10231	October 2007	October 2011



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CONCLUSIONS:

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the relevant clauses of Federal Communications Commission Rules for intentional radiators (part 15 subpart C) and unintentional radiators (part 15 subpart B)

Zuständiger Laborleiter:
Responsible head of laboratory:

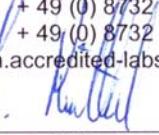
22.03.2010

(Datum/Date)

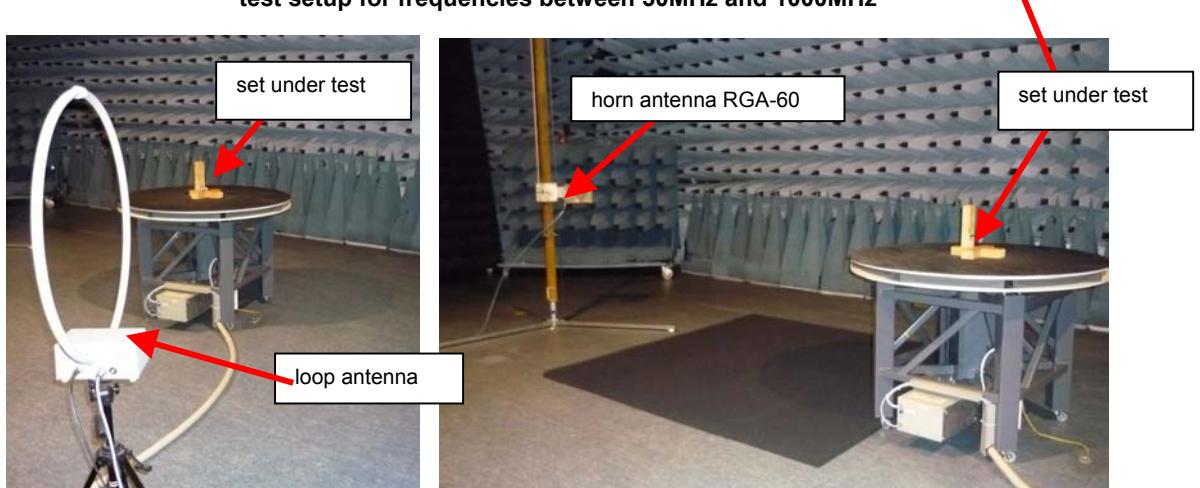
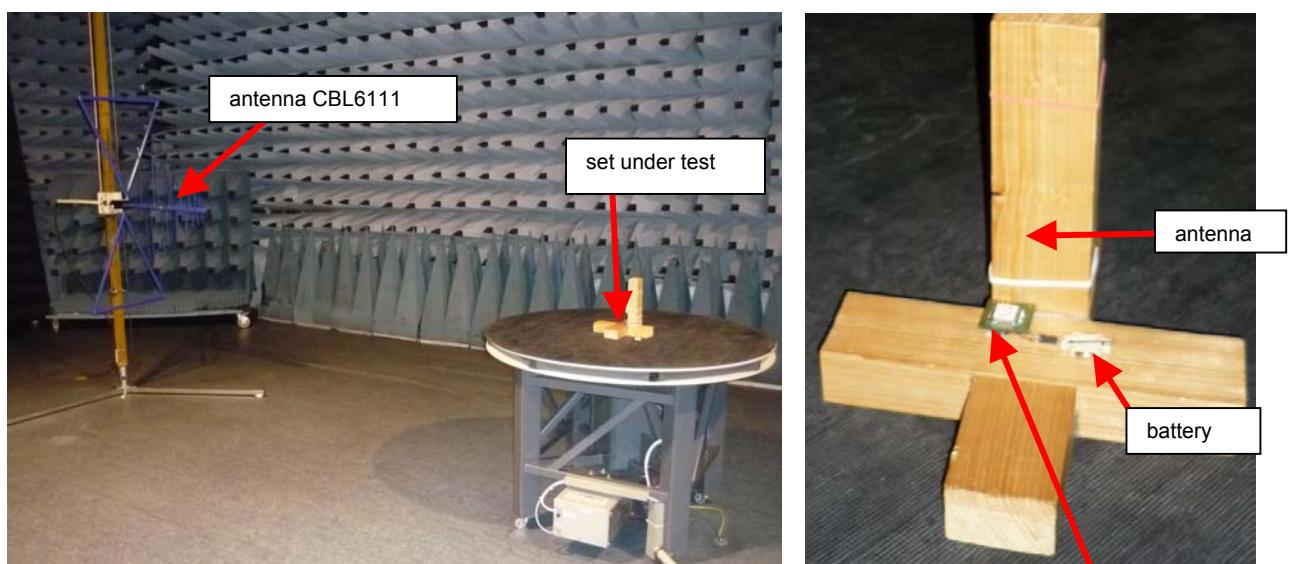
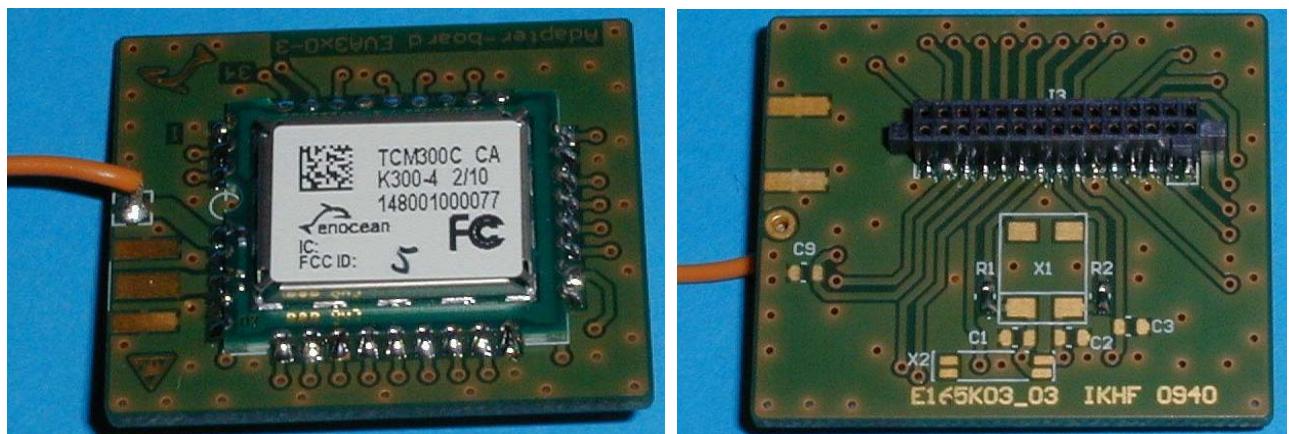
G. Raithel Dipl.-Ing. (FH)
(Name/Name)

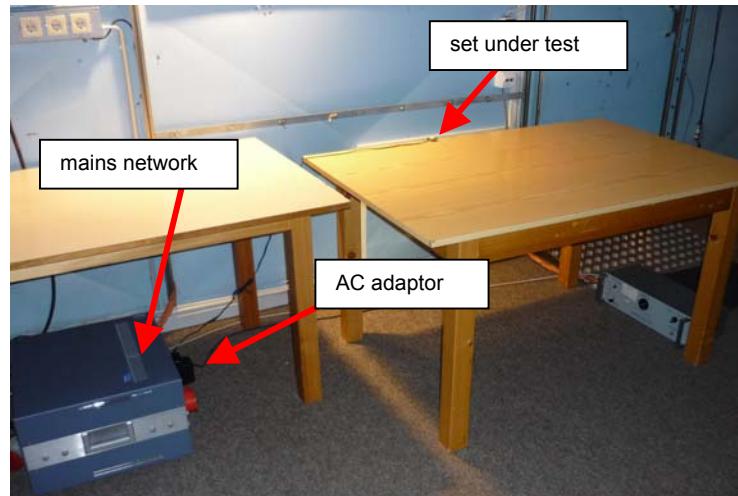
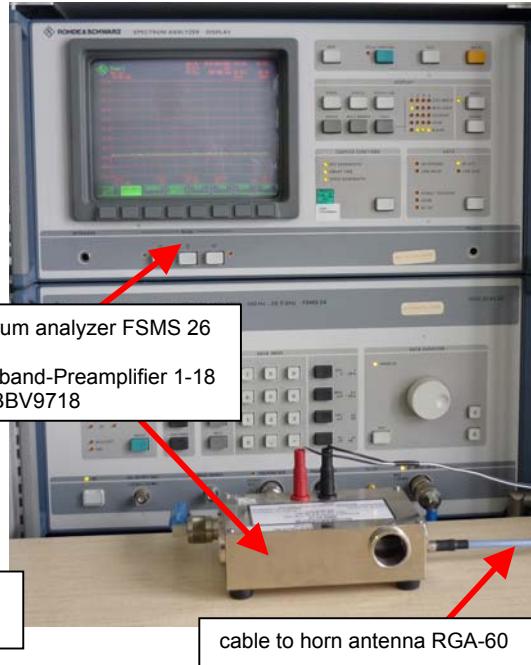
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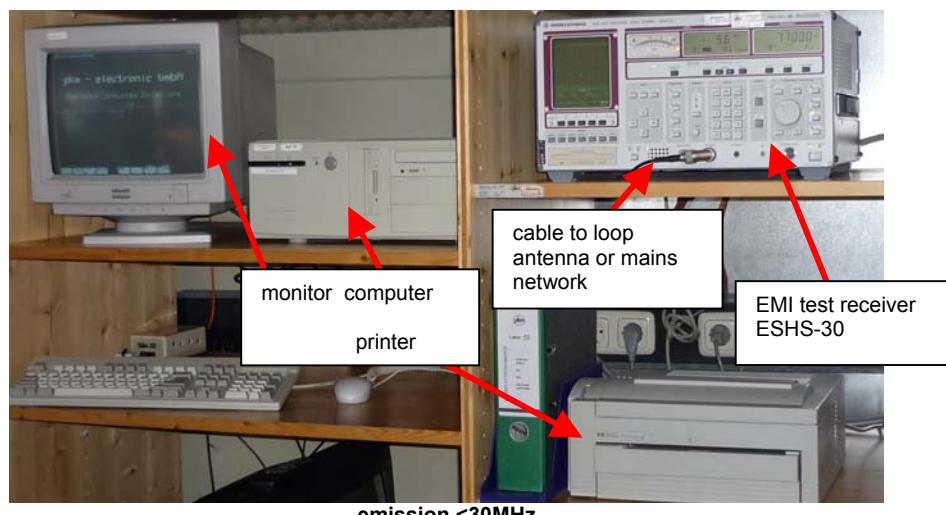

(Unterschrift/Signature)

9. PHOTOS





conducted emission 150 kHz - 30 MHz

**End of test report**