

TEST REPORT

Test Report Reference: R71209 Edition 1

Equipment under Test: IVTM ECU

Serial Number: 084022

Article Number: 446 220 013 0

FCC ID: SA4-ECU220

Applicant: WABCO GmbH & Co. OHG

Manufacturer: WABCO GmbH & Co. OHG

**Test Laboratory
(CAB)**

**accredited by DATech GmbH
in compliance with DIN EN ISO/IEC 17025
under the Reg. No. DAT-P-105/99-21,**

**recognized by Bundesnetzagentur
under the Reg.-No. BNetzA-CAB-02/21-104/1,**

CAB Designation Number DE0004,

**listed by
FCC 31040/SIT1300F**

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1 IDENTIFICATION

1.1 APPLICANT

Name:	WABCO GmbH & Co. OHG
Address:	Am Lindener Hafen 21 30453 Hannover
Country:	Germany
Name for contact purposes:	Mr. Michael Brand
Phone:	+49 511 922 2434
Fax:	+49 511 2 15 30 39
Mail address:	michael.brand@wabco-auto.com
Applicant represented during the test by the following person:	---

1.2 MANUFACTURER

Name:	WABCO GmbH & Co. OHG
Address:	Am Lindener Hafen 21 30453 Hannover
Country:	Germany
Name for contact purposes:	Mr. Michael Brand
Phone:	+49 511 922 2434
Fax:	+49 511 2 15 30 39
Mail address:	michael.brand@wabco-auto.com
Applicant represented during the test by the following person:	---

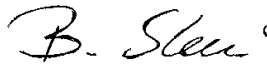
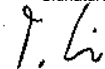
1.3 DATES

Date of receipt of test sample:	20 April 2007
Start of test:	7 May 2007
End of test:	11 June 2007

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1.4 TEST LABORATORY

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
D-32825 Blomberg Phone: **+49 (0) 52 35 / 95 00-0**
Germany Fax: **+49 (0) 52 35 / 95 00-10**

Test engineer:	<div>Bernd STEINER <small>Name</small></div>	<div> <small>Signature</small></div>	<div>12 July 2007 <small>Date</small></div>
Test report checked:	<div>Thomas KÜHN <small>Name</small></div>	<div> <small>Signature</small></div>	<div>12 July 2007 <small>Date</small></div>

PHOENIX TESTLAB GmbH
Königswinkel 10
32825 Blomberg
Tel. 0 52 35 / 95 00-0
Fax 0 52 35 / 95 00-10

Stamp

1.5 RESERVATION

This test report is only valid in its original form.

Any reproduction of its contents without written permission of the accredited test laboratory PHOENIX TESTLAB GmbH is prohibited.

The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT REFERENCE.

1.6 NORMATIVE REFERENCES

- [1] **ANSI C63.4-2003** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- [2] **FCC 47 CFR Part 2** General Rules and Regulations
- [3] **FCC 47 CFR Part 15** Radio Frequency Devices (Subpart C)

1.7 TEST RESULTS

The requirements of this test document are fulfilled by the equipment under test. The complete test results are presented in the following.

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2 TECHNICAL DATA OF EQUIPMENT

2.1 DEVICE UNDER TEST

Type of equipment:	Tire pressure control unit for truck use
Type designation:*	IVTM ECU
Article No.:	446 220 013 0
FCC ID:	SA4-ECU220
Highest/Lowest internal frequency*	433.92 MHz / 4.75 MHz
Antenna type:	Integral
Software	none

* as declared by the applicant

The following external I/O cables were used:

A suitable cable harness with a length of 10 m was connected to the IVTM ECU. The CAN - interface was left open.

2.2 PEREPHERY DEVICES

The following equipment was used as control unit and ancillary equipment:

none

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3 ADDITIONAL INFORMATION

Because the equipment under test runs in testmodes only the transmission limitation up to 2 s can't be measured by the testlaboratory.

4 OPERATIONAL STATES AND PHYSICAL BOUNDARIES

For the transmitter emission measurement in the IVTM ECU was set in CW mode which was reached by a jumper on the pcb. This jumper was implemented by the applicant for testing purposes only.

For the measurement of the duty cycle and the occupied bandwidth the device was set into the operation mode "Tire A" which has the maximum ON/OFF ratio as declared by the applicant. In this mode the data were transmitted repetitively each second. This was reached by connecting the device via a CAN / RS 232 converter to the serial port of a PC. On this PC the software UDT was running. With the configuration file KWPVIACAN_RETROFIT_TRAILER_IVTM_RFtest.UDS the IVTM ECU was set in the requested operation mode.

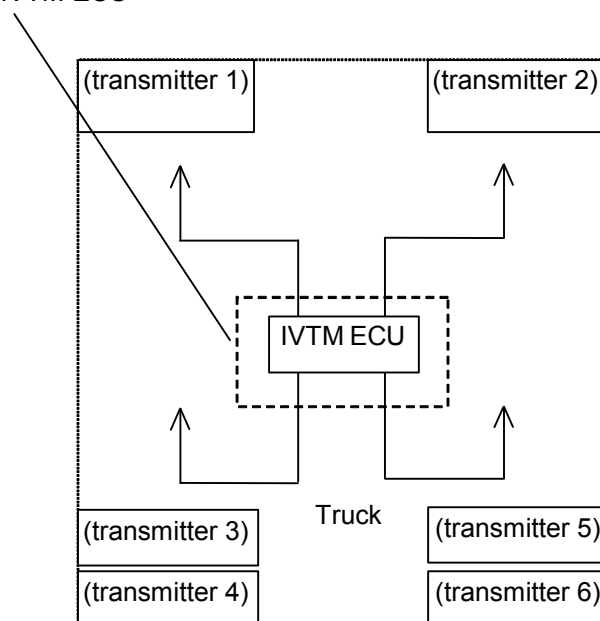
For the receiver spurious emission measurement the IVTM ECU was set in normal operation mode and the brake line was connected to the plus pole of the power supply

This was done by instructions of Mr. Michael Brand from WABCO GmbH & Co. OHG

Unless otherwise stated the EUT was supplied by 24 V DC.

The physical boundaries of the Equipment Under Test are shown below.

Physical boundary of the IVTM ECU



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5 LIST OF TEST MODULES

Radiated Emissions fundamental frequency FCC 47 CFR Part 15 section 15.231 (b) [3]						
No.	Application	Fundamental Frequency	Limits	Reference standard	Remark	Status
1	Intentional radiator (fundamental frequency)	433.92 MHz	80.82 dB μ V/m at 3m 10998 μ V/m at 3m	ANSI C63.4 (2003);	-	Passed
Transmitter Unwanted Emission FCC 47 CFR Part 15 section 15.231 (b) [3]						
No.	Application	Fundamental Frequency	Limits	Reference standard	Remark	Status
2	Intentional radiator (spurious emissions)	433.92 MHz	60.82 dB μ V/m at 3m	ANSI C63.4 (2003);	-	Passed
Radiated emissions in restricted bands FCC 47 CFR Part 15 section 15.209 [3]						
No.	Application	Frequency of Emission	Limits	Reference standard	Remark	Status
3	Radiated emissions	30 to 88 MHz 88 to 216 MHz 216 to 960 MHz Above 960 MHz	40 dB μ V/m at 3 m 43 dB μ V/m at 3 m 46 dB μ V/m 3 m 54 dB μ V/m 3m	ANSI C63.4 (2003);	-	Passed
Bandwidth of Momentary Signals FCC 15.231 (c) [3]						
No.	Application	Fundamental Frequency	Limits	Reference standard	Remark	Status
4	20dB Bandwidth	433.92 MHz	0.25 % of the center frequency	ANSI C63.4 (2003);	-	Passed
Antenna requirement FCC 47 CFR Part 15 section 15.203 [3]						
						Status
The EUT has an integrated antenna only						Passed

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6 METHOD OF MEASUREMENT

6.1 RADIATED EMISSIONS

The radiated emission measurement is subdivided into four stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 1 GHz.
- A final measurement carried out on an outdoor test side without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A final measurement carried out on an open area test side with reflecting ground plane and various antenna height in the frequency range 30 MHz to 1 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 5 GHz.

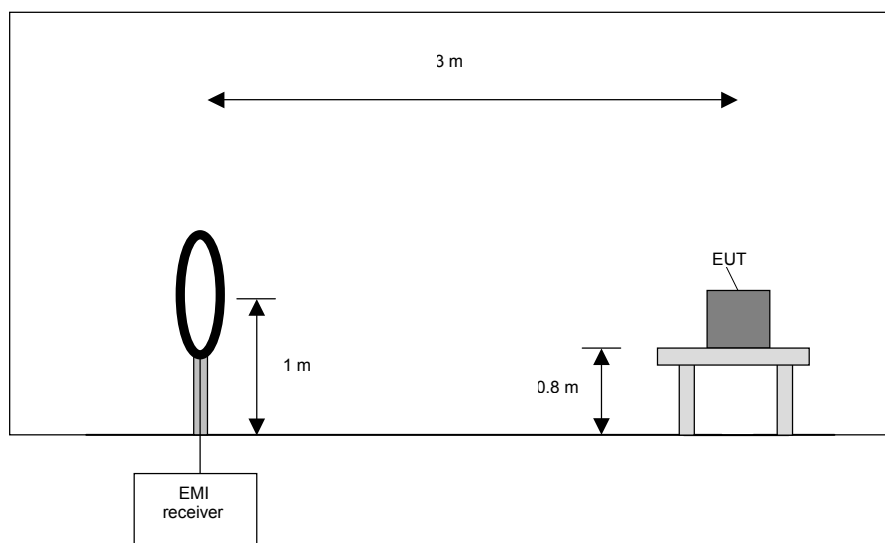
Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2003 [1].

The frequency range 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to found the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



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Preliminary measurement procedure:

Prescans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

The following procedure will be used:

- 1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
- 2) Manipulate the system cables within the range to produce the maximum level of emission.
- 3) Rotate the EUT by 360 ° to maximize the detected signals.
- 4) Make a hardcopy of the spectrum.
- 5) Measure the frequencies of highest detected emission with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
- 6) Repeat steps 1) to 5) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).
- 7) Rotate the measuring antenna and repeat steps 1) to 5).

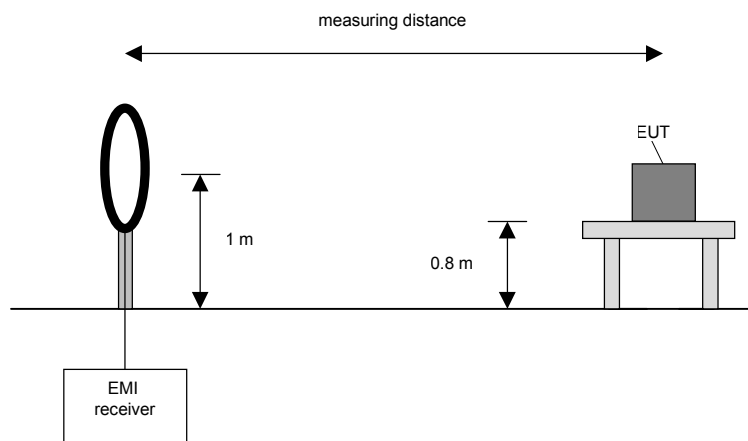
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m and 30 m if possible. In the case where larger measuring distances are required the results will be extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with a EMI Receiver set to Quasi Peak detector except for the frequency bands 30 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according Section 15.209 (d) [2].

On the during the preliminary measurement detected frequencies the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



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Final measurement procedure:

The following procedure will be used:

- 1) Monitor the frequency range with the measuring antenna at vertical orientation parallel to the EUT at an azimuth of 0 °.
- 2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
- 3) Rotate the measuring antenna to find the maximum and note the value.
- 4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
- 5) Repeat steps 1) to 4) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).

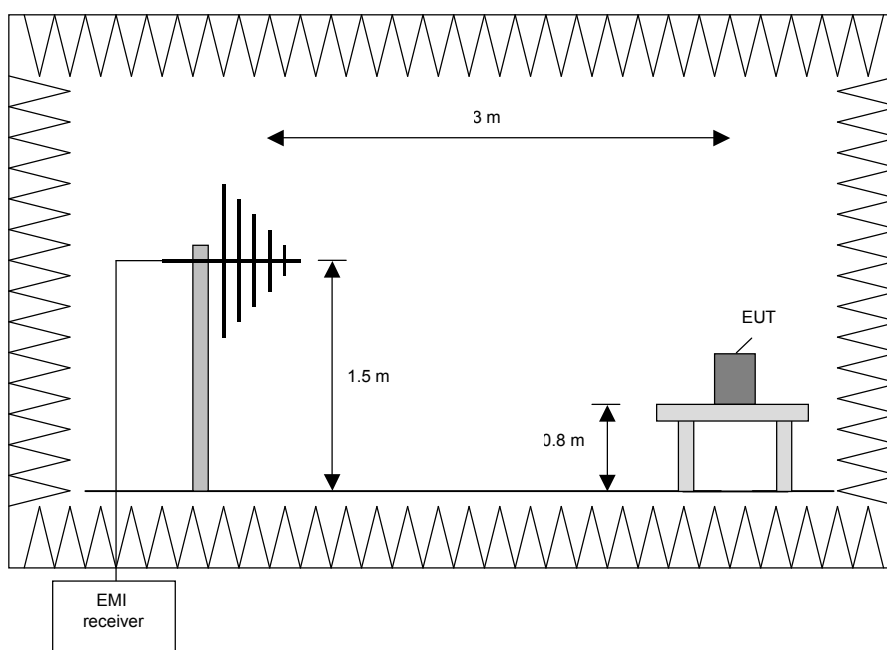
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2003 [1].

The frequency range 30 MHz to 1 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz



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Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.

The following procedure will be used:

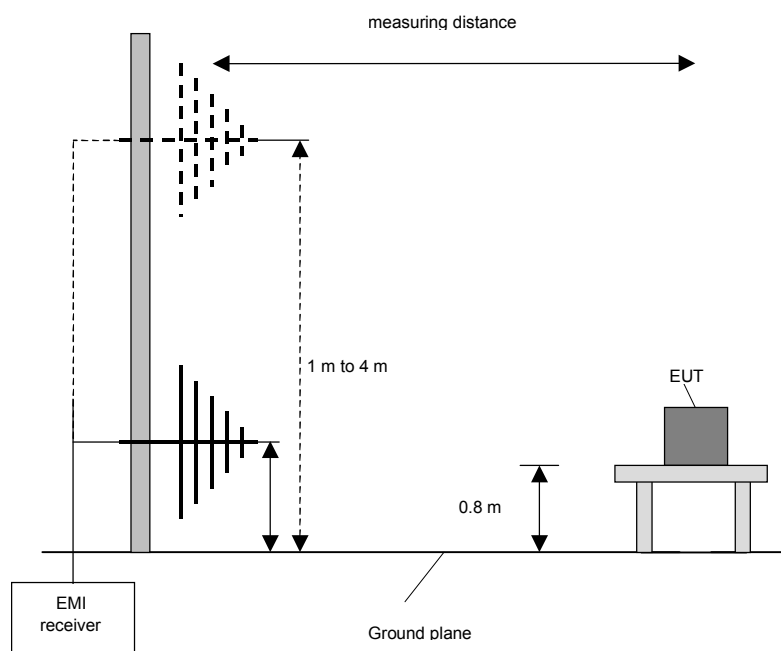
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6. Repeat 1) to 4) with the other orthogonal axes of the EUT if handheld equipment.
7. Repeat 1) to 5) with the vertical polarisation of the measuring antenna.

Final measurement (30 MHz to 1 GHz)

A final measurement on an open area test site will be performed on selected frequencies found in the preliminary measurement. During this test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarisation and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



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Procedure final measurement:

The following procedure will be used:

- 1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
- 2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
- 3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
- 4) Repeat 1) to 3) for the other orthogonal antenna polarization.
- 5) Move the antenna and the turntable to the position where the maximum value is detected.
- 6) Measure while moving the antenna slowly +/- 1 m.
- 7) Set the antenna to the position where the maximum value is found.
- 8) Measure while moving the turntable +/- 45 °.
- 9) Set the turntable to the azimuth where the maximum value is found.
- 10) Measure with Final detector (QP and AV) and note the value.
- 11) Repeat 5) to 10) for each frequency.
- 12) Repeat 1) to 11) for each orthogonal axes of the EUT if handheld equipment.

Preliminary and final measurement (1 GHz to 5 GHz)

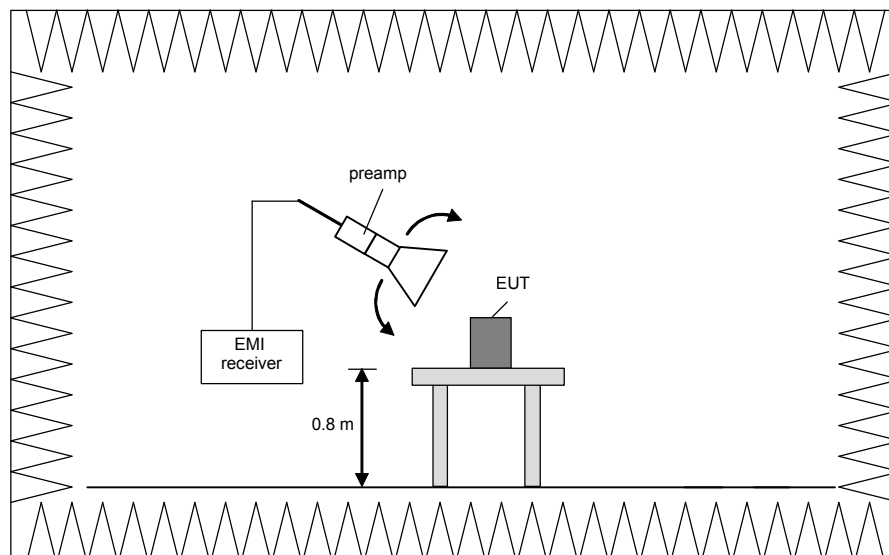
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to ANSI C63.4-2003 [1].

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth (preliminary)	Resolution bandwidth (final)
1 GHz to 5 GHz	100 kHz	1 MHz

Preliminary measurement (1 GHz to 5 GHz)

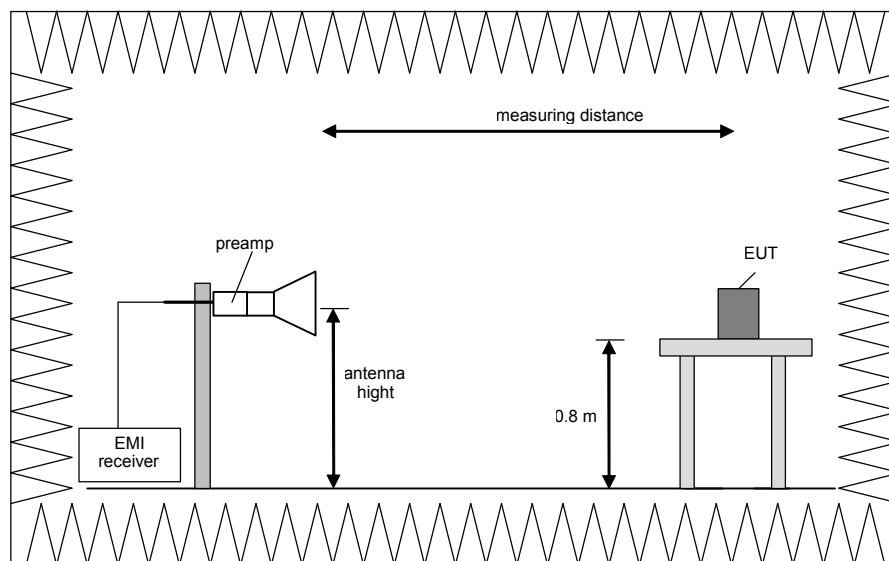
The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna, the antenna close to the EUT and while moving the antenna over all sides of the EUT. With the spectrum analyser in CLEAR / WRITE mode the cone of the emission should be found and than the measuring distance will be set to 3 m with the receiving antenna moving in this cone of emission. At this position the final measurement will be carried out.



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Final measurement (1 GHz to 5 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 ° in order to have the antenna inside the cone of radiation.



Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 5 GHz.

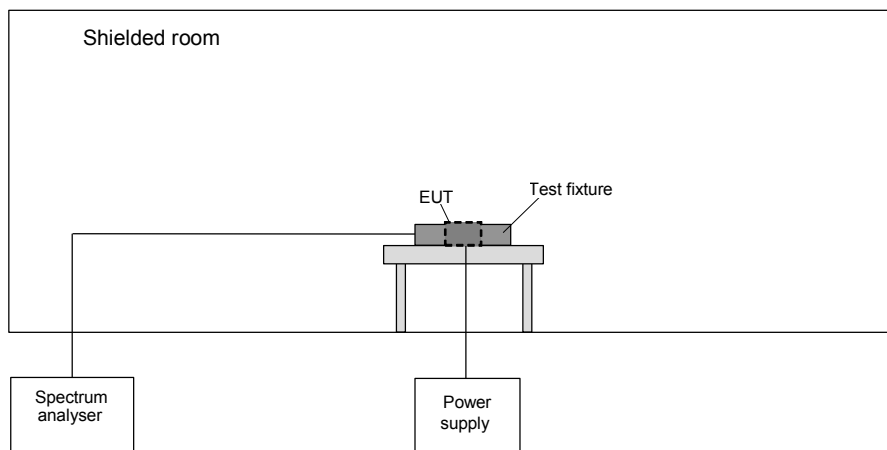
The following procedure will be used:

- 1) Monitor the frequency range at horizontal polarisation and move the antenna over all sides of the EUT (if necessary move the EUT to another orthogonal axis).
- 2) Change the antenna polarisation and repeat 1) with vertical polarisation.
- 3) Make a hardcopy of the spectrum.
- 4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
- 5) Change the analyser mode to Clear / Write and found the cone of emission.
- 6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3 m and the antenna will be still inside the cone of emission.
- 7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarisation and azimuth and the peak and average detector, which causes the maximum emission.
- 8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beam width.

Step 1) to 6) are defined as preliminary measurement.

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6.2 20 dB BANDWIDTH



The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on, the transmitter shall work with its maximum data rate.

The following spectrum analyser settings shall be used:

- Span: App. 2 to 3 times the 20 dB bandwidth.
- Resolution bandwidth: 1 % of the selected span
- Video bandwidth: 3 times the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The first display line has to be set on this value. The second display line has to be set 6 dB below the first line (or the peak marker). The frequency lines shall be set on the intersection points between the second display line and the measured curve.

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7 MEASUREMENT RESULTS

7.1 TRANSMITTER

7.1.1 PRELIMINARY RADIATED EMISSION MEASUREMENT (9 kHz to 1 GHz)

Ambient temperature	20 °C	Relative humidity	38 %
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Position of EUT: The EUT was set-up on a wooden table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

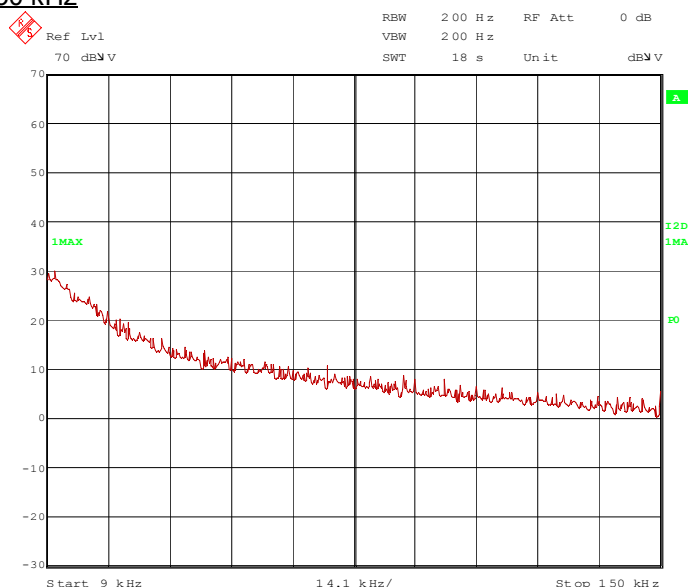
Cable guide: The cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Operation mode: The test was carried out in CW mode of the EUT. All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied by 24 V DC because pretests have shown that a variation of the supply voltage in the range from 20.4 V to 27.6 V (85 % to 115 %) will not change the level of the fundamental.

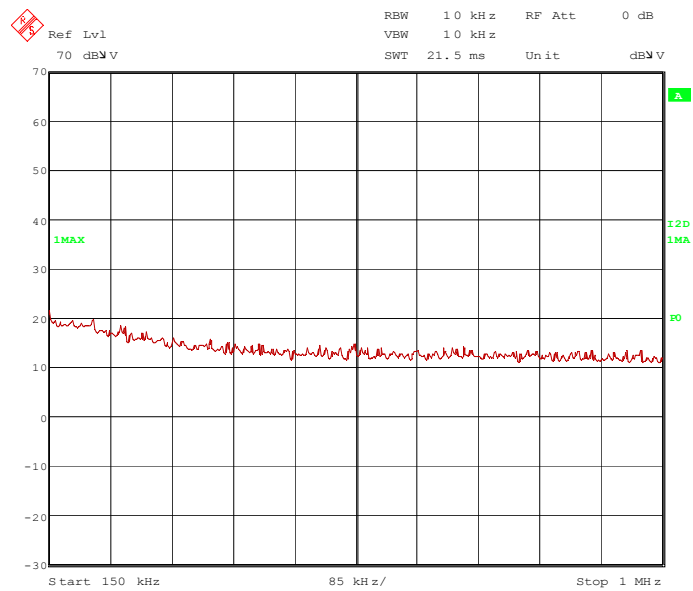
Test results:

71209_6.wmf: 9 kHz to 150 kHz

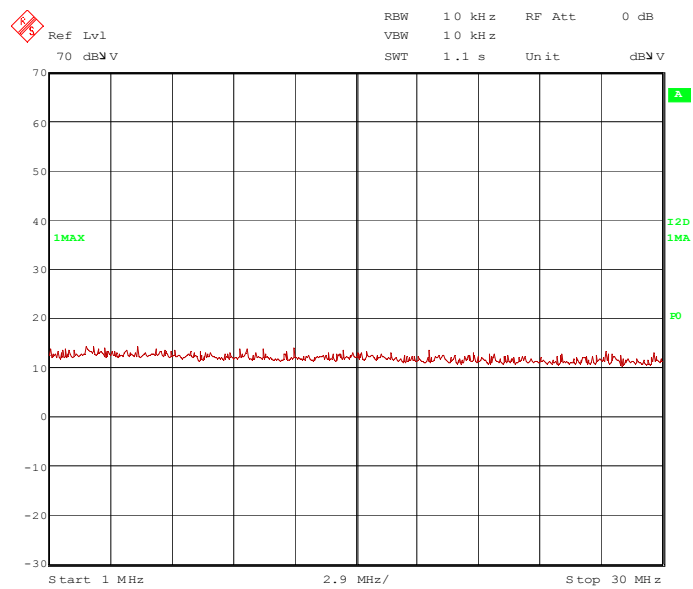


TEST REPORT REFERENCE: R71209 Edition 1

71209_7.wmf: 150 kHz to 1 MHz

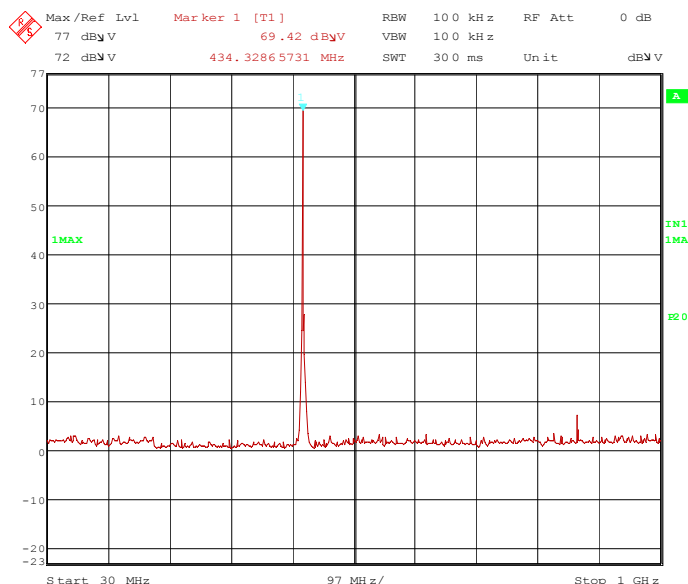


71209_8.wmf: 1 MHz to 30 MHz



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71209_3.wmf: 30 MHz to 1 GHz



The following significant frequencies were found during the preliminary radiated emission test:

- 433.934 MHz
- 867.868 MHz

The following frequencies were found inside the restricted bands according to FCC 47 CFR Part 15 section 15.205 [3].

- No frequencies found inside the restricted bands.

These frequencies have to be measured on the open area test site. The results of this final measurement are shown in subclause 7.1.2 of this test report.

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 35, 43, 54, 56

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7.1.2 FINAL RADIATED EMISSION MEASUREMENT (30 MHz to 1 GHz)

Ambient temperature	22 °C	Relative humidity	43 %
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Position of EUT: The EUT was set-up on a wooden table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: The cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Operation mode: The test was carried out in CW mode of the EUT. All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied by 24 V DC.

Test results: The results of the standard final measurement on the open area test site are indicated in the table below. The limits as well as the measured results (levels) refer to the above-mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

Results measured with the peak detector (and calculated to average):

Fundamental emission										
Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings Peak dBµV	Antenna factor 1/m	Cable loss dB	Average correction factor [dB]	Height cm	Azimuth deg	Pol.
433.934	76.0	80.8	4.8	72.1	16.4	3.9	-16.4	100	205	Hor.
Highest spurious emissions outside restricted bands										
Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings Peak dBµV	Antenna factor 1/m	Cable loss dB	Average correction factor [dB]	Height cm	Azimuth Deg	Pol.
867.868	23.7	60.8	37.1	12.5	22.2	5.4	-16.4	142	182	Ver.
Three highest spurious emissions in restricted bands										
No emissions in restricted bands found										

The test results were calculated with the following formula:

Result [dBµV/m] = reading [dBµV] + cable loss [dB] + antenna factor [dB/m] + average correction factor [dB]

Remark: The Average correction factor was taken from the calculation see subclause 7.1.5

Test result: Passed

TEST EQUIPMENT USED FOR THE TEST:

14 – 20, 54

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7.1.3 PRELIMINARY RADIATED EMISSION MEASUREMENT (1 GHz to 5 GHz)

Ambient temperature	20 °C	Relative humidity	46 %
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Position of EUT: The EUT was set-up on a wooden table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

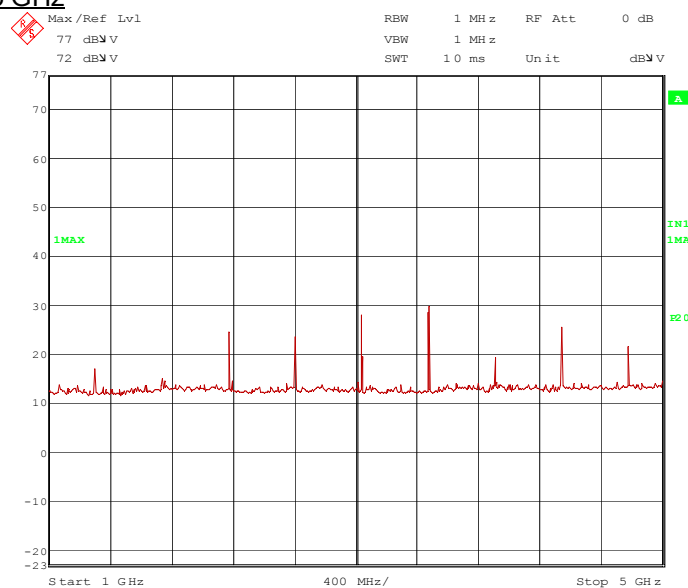
Cable guide: The cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Operation mode: The test was carried out in CW mode of the EUT. All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied by 24 V DC.

Test results:

71209_4.wmf: 1 GHz to 5 GHz



The following significant frequencies were found during the preliminary radiated emission test:

- 1735.605 MHz; 2169.631 MHz; 2603.511 MHz; 3037.490 MHz; 3471.149 MHz

The following frequencies were found inside the restricted bands according to FCC 47 CFR Part 15 section 15.205.

- 1301.771 MHz; 3905.310 MHz; 4339.019 MHz; 4773.092 MHz

On these frequencies a final measurement has to take place. The results of this final measurement are shown in subclause 7.1.4 of this test report.

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 34, 36, 44, 54

TEST REPORT REFERENCE: R71209 Edition 1

7.1.4 FINAL RADIATED EMISSION TEST (1 GHz to 5 GHz)

Ambient temperature	20 °C	Relative humidity	46 %
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Position of EUT: The EUT was set-up on a wooden table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: The cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Operation mode: The test was carried out in CW mode of the EUT. All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied by 24 V DC.

Test results:

Results measured with the peak detector (and calculated to average):

Frequency MHz	Result dBμV/m	Limit dBμV/m	Margin dB	Readings dBμV	Antenna factor 1/m	Cable loss dB	Average correction factor [dB]	Height cm	Pol.	Restricted Band
1301.691	31.7	54.0	22.3	20.3	25.2	2.6	-16.4	150	Hor.	Yes
1735.731	30.7	60.8	30.1	16.8	27.3	3.0	-16.4	150	Hor.	No
2169.731	44.3	60.8	16.5	29.4	27.9	3.4	-16.4	150	Hor.	No
2603.631	40.5	60.8	20.4	24.4	28.8	3.7	-16.4	150	Vert.	No
3037.591	48.5	60.8	12.3	30.4	30.5	4.0	-16.4	150	Hor.	No
3471.392	49.3	60.8	11.6	29.9	31.5	4.3	-16.4	150	Vert.	No
3905.290	42.4	54.0	11.6	21.5	32.9	4.4	-16.4	150	Hor.	Yes
4339.070	48.3	54.0	5.7	27.6	32.4	4.7	-16.4	150	Hor.	Yes
4773.112	46.2	54.0	7.8	24.4	33.1	5.1	-16.4	150	Hor.	Yes

The test results were calculated with the following formula:

Result [dBμV/m] = reading [dBμV] + cable loss [dB] + antenna factor [dB/m] + average correction factor [dB]

Remark: The Average correction factor was taken from the calculation see subclause 7.1.5

Test result: passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 – 34, 36, 43, 54

TEST REPORT REFERENCE: R71209 Edition 1

7.1.5 CALCULATION OF THE AVERAGE CORRECTION FACTOR

Because of pulsed transmission all measurements were carried out with a peak detector and the average value is calculated over a pulse train of 100 ms as required in FCC 47 CFR Part 15 section 15.35 [3]

To calculate the average value a complete pulse train was measured. A detail view to a pulse period was taken and the transmitter-on-time was recorded. This time was used to calculate the average correction factor.

Summary of the complete pulsetrain:

One pulsetrain consists of

2 pulses type 1: $2 * 478.958 \mu\text{s} = 957.916 \mu\text{s}$

27 pulses type 2: $27 * 236.473 \mu\text{s} = 6384.771 \mu\text{s}$

67 pulses type 3: $67 * 114.228 \mu\text{s} = 7653.276 \mu\text{s}$

total on time of the pulsetrain = $14995.963 \mu\text{s}$

total length of pulsetrain = 99.108216 ms

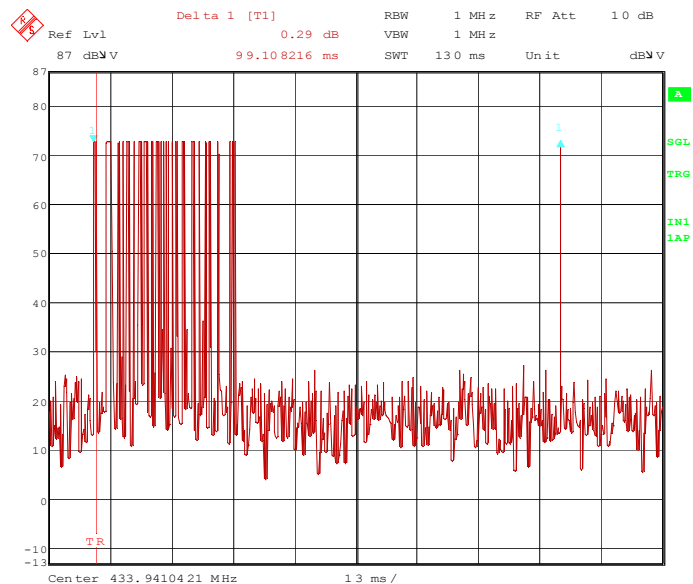
Duty cycle correction factor according to FCC 47 CFR Part 15 section 15.35 [3]

$F [\text{dB}] = 20 * \log (14995.963 \mu\text{s} / 99.108216 \text{ ms}) = -16.4 \text{ dB}$

Please refer also to the plots in the following.

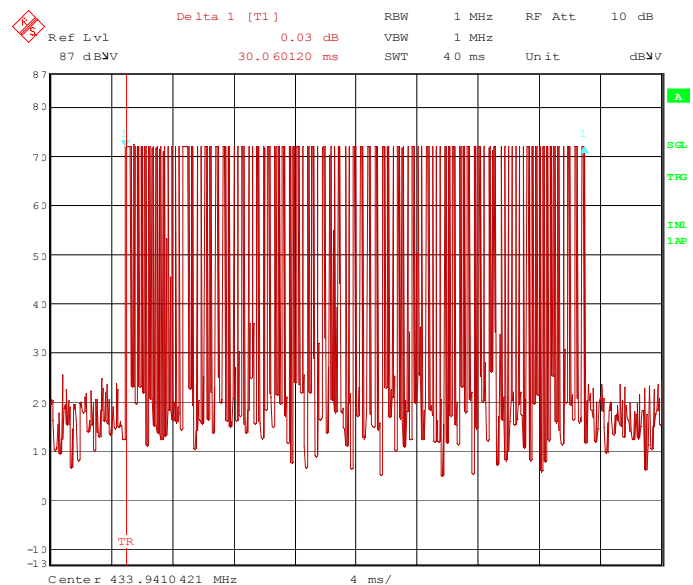
TEST REPORT REFERENCE: R71209 Edition 1

71209_1.WMF (view of complete pulsetrain)



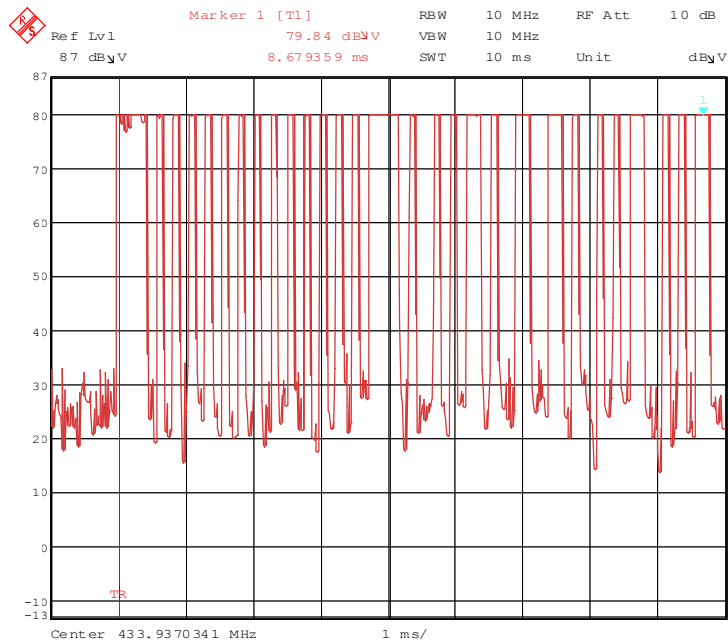
Total length of pulse emission= 99.108216 ms

71209_3.WMF (detail view of the pulse train):

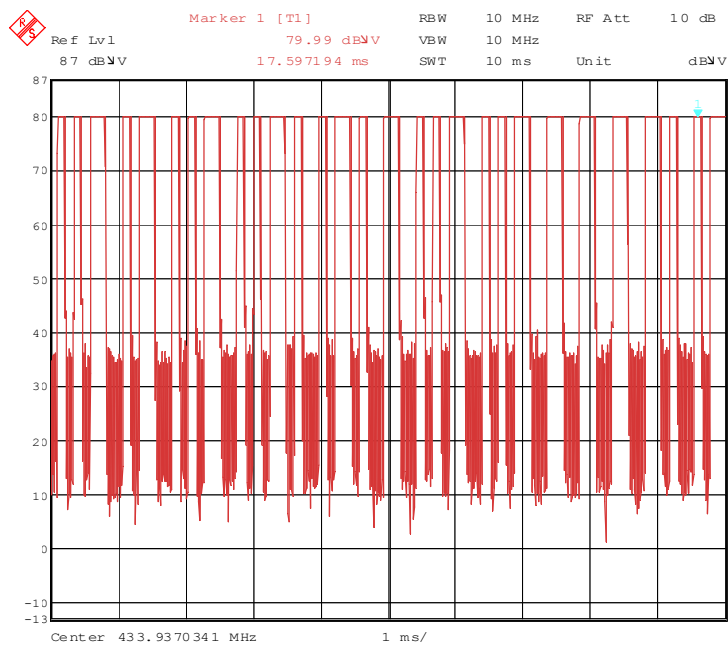


TEST REPORT REFERENCE: R71209 Edition 1

71209_20.WMF (1st detail view to sub pulse train):

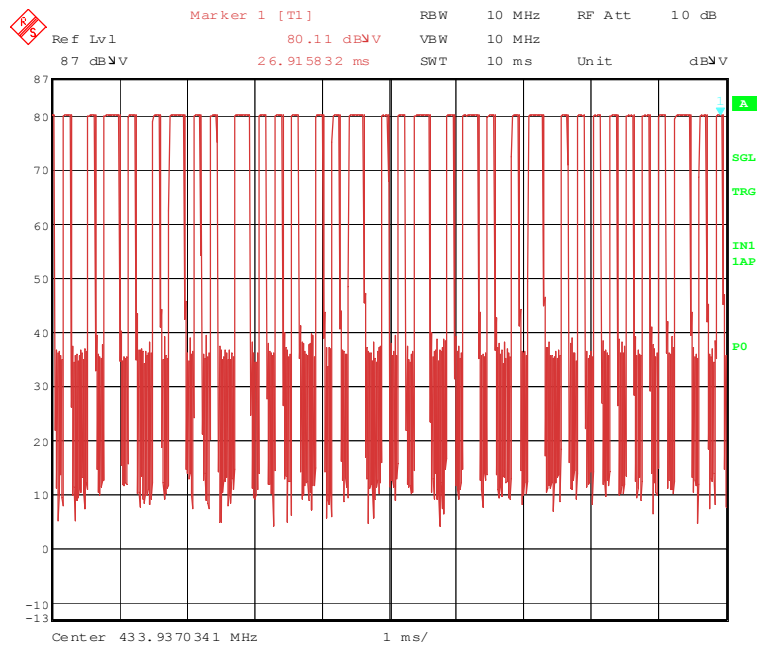


71209_21.WMF (2nd detail view to sub pulse train):

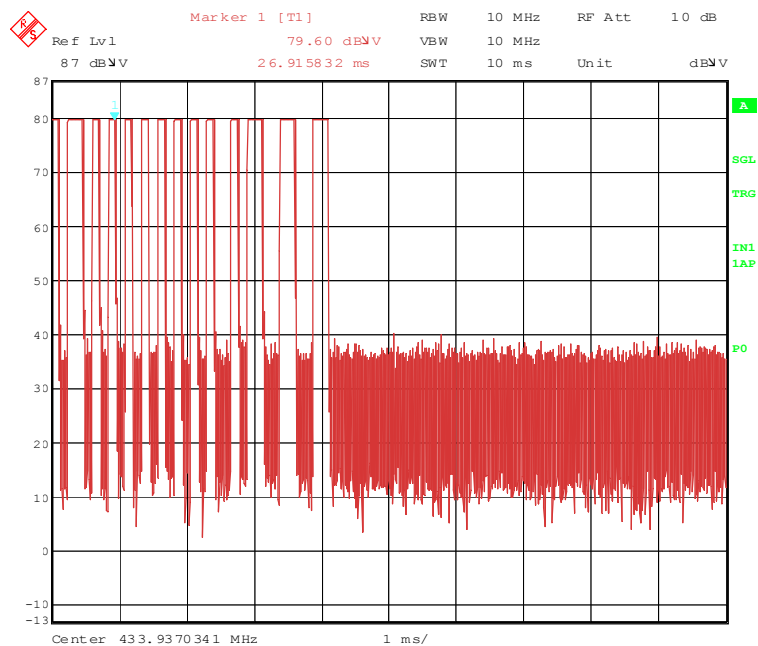


TEST REPORT REFERENCE: R71209 Edition 1

71209_22.WMF (3rd detail view to sub pulse train):

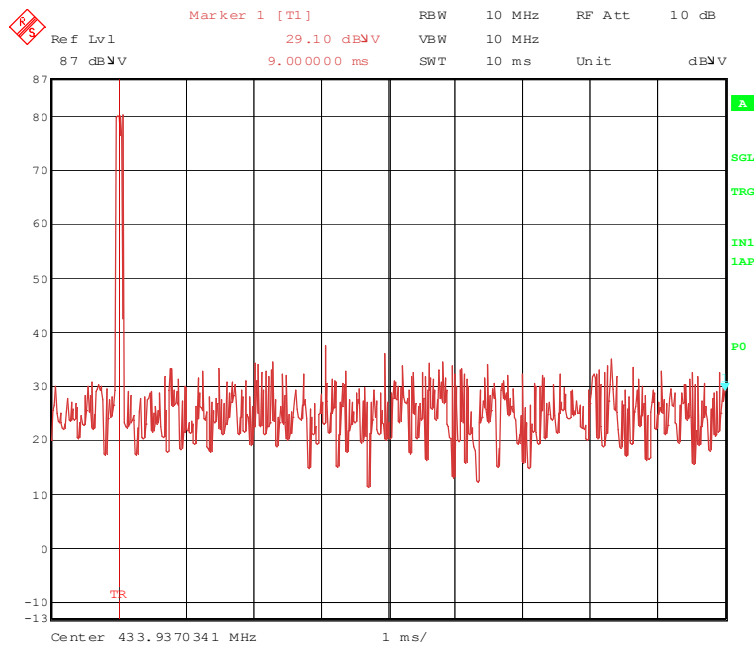


71209_23.WMF(4th detail view to sub pulse train):

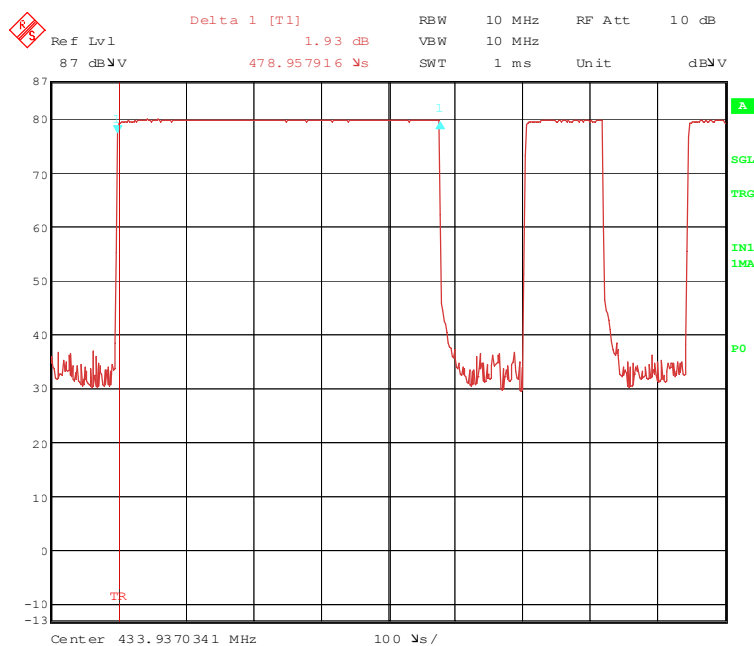


TEST REPORT REFERENCE: R71209 Edition 1

71209_24.WMF (5th detail view to sub pulse train):

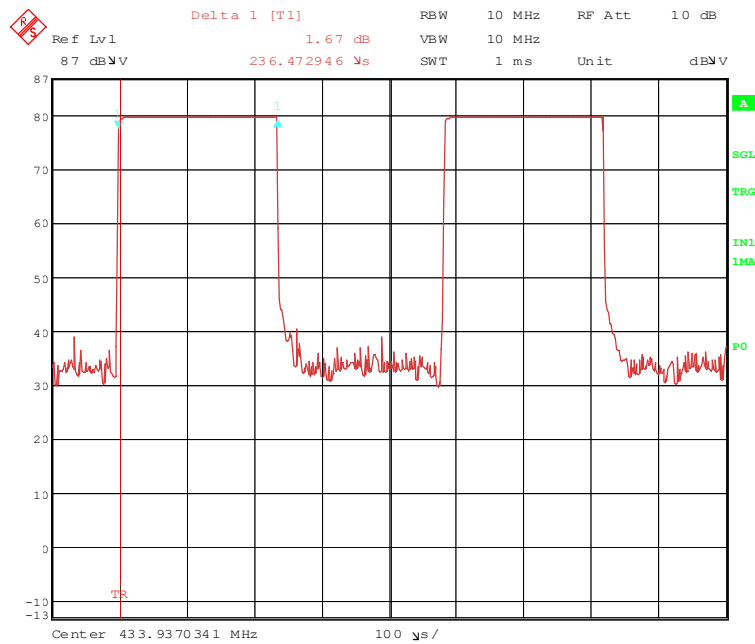


71209_duty10.WMF (detail view pulse type 1):

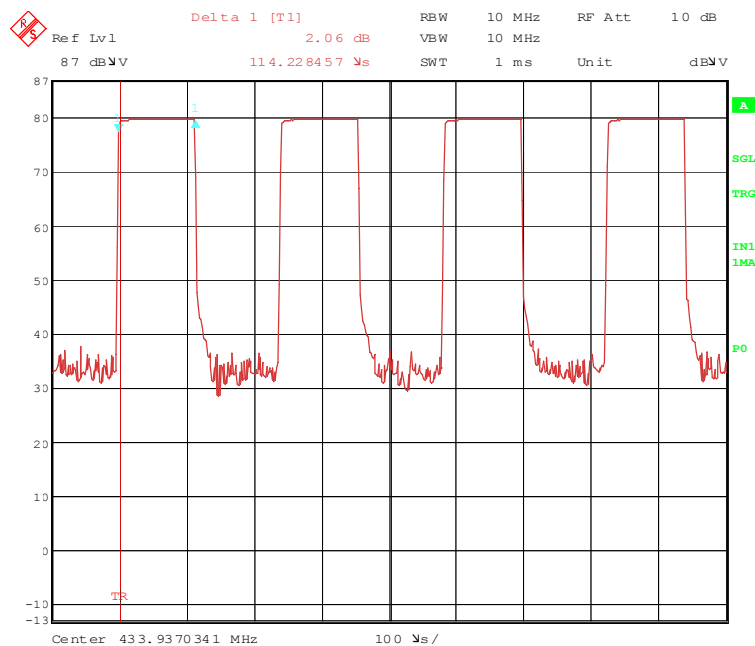


TEST REPORT REFERENCE: R71209 Edition 1

71209_duty11.WMF (detail view pulse type 2):



71209_duty12.WMF (detail view pulse type 3):



TEST EQUIPMENT USED THE TEST:

31, 54, 58, 59

TEST REPORT REFERENCE: R71209 Edition 1

7.1.6 20dB BANDWIDTH

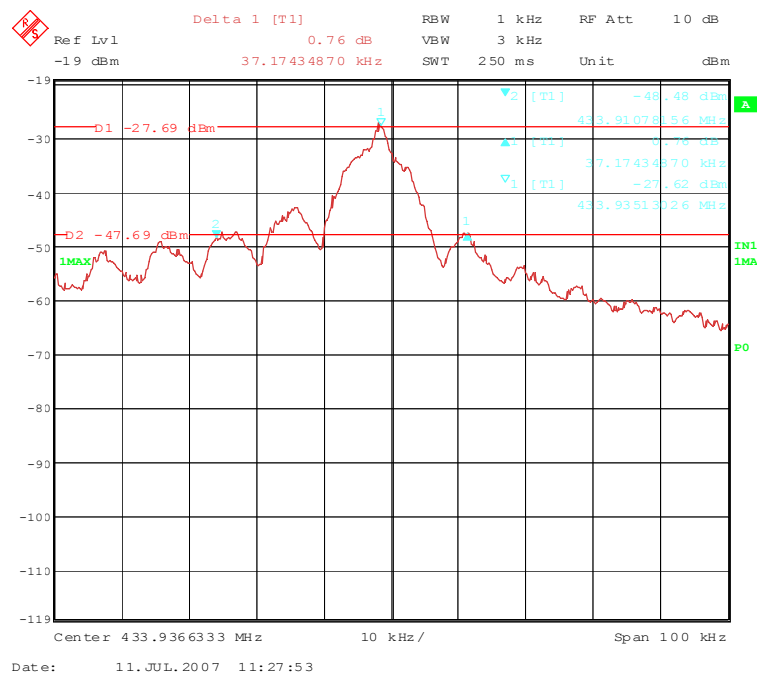
Ambient temperature:	20 °C	Relative humidity:	46 %
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Test record: The test was carried out in operation mode "Tire A" of the EUT. All results are shown in the following.

Operation mode: Tire "A"

Supply voltage: During all measurements the EUT was supplied by 24 V DC.

71209 20dB b.wmf: 20dB bandwidth



Measured Bandwidth	Limit
37.1743 kHz	1.08 MHz (0.25% of 433.92MHz)

Test: Passed

TEST EQUIPMENT USED THE TEST:

31, 54, 58, 59

TEST REPORT REFERENCE: R71209 Edition 1

8 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

TEST REPORT REFERENCE: R71209 Edition 1

Emission measurement at AC mains and DC in / out ports at M4					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
1	Shielded chamber M4	-	Siemens	B83117S1-X158	480088
2	Measuring receiver	ESAI	Rohde & Schwarz	831953/001 833181/018	480025 480026
3	LISN	NSLK8128	Schwarzbeck	8128155	480058
4	DC-filter	B84266-A21-E13	Siemens	940164525	480099
5	AC-filter	B84299-D87-E3	Siemens	930262292	480097
6	EMI-Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M5					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
7	Fully anechoic chamber M5	-	Siemens	B83177-S1-X156	480073
8	Measuring receiver	ESVS30	Rohde & Schwarz	829673/012	480024
9	Controller	HD100	Deisel	100/324	480067
10	Antenna support	MA240	Deisel	228/314	480069
11	Turntable	DS412	Deisel	412/317	480070
12	Antenna	CBL6112C	Chase	2689	480327
13	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M6					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
14	Open area test site	-	Phoenix Test-Lab	-	480085
15	Measuring receiver	ESVS30	Rohde & Schwarz	829673/012	480024
16	Controller	HD100	Deisel	100/670	480139
17	Turntable	DS420HE	Deisel	420/620/80	480087
18	Antenna support	AS615P	Deisel	615/310	480086
19	Antenna	CBL6111 A	Chase	1643	480147
20	EMI Software	ES-K1	Rohde & Schwarz	-	480111

TEST REPORT REFERENCE: R71209 Edition 1

Radiated emission measurement at M8					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
21	Fully anechoic chamber M8	-	Siemens	B83117-E7019-T231	480190
22	Measuring receiver	ESMI	Rohde & Schwarz	843977/001 843530/018	480179 480180
23	Measuring receiver	ESCS 30	Rohde & Schwarz	828985/014	480270
24	Controller	HD100	Deisel	100/427	480181
25	Turntable	DS420	Deisel	420/435/97	480186
26	Antenna support	AS615P	Deisel	615/310	480187
27	Antenna	CBL6112 A	Chase	2034	480185
28	EMI Software	ES-K1	Rohde & Schwarz	-	480111
Radiated emission measurement at M20					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303
30	Measuring receiver	ESMI	Rohde & Schwarz	843977/001 843530/018	480179 480180
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355
32	Controller	HD100	Deisel	100/670	480326
33	Turntable	DS420HE	Deisel	420/620/80	480315
34	Antenna support	AS615P	Deisel	615/310	480187
35	Antenna	CBL6112 B	Chase	2688	480328
36	Antenna	3115 A	EMCO	9609-4918	480183
37	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294
38	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	482	480295
39	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297
40	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	410	480296
41	Standard Gain Horn 26.4 GHz – 40.1 GHz	22240-20	Flann Microwave	469	480299

TEST REPORT REFERENCE: R71209 Edition 1

No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
42	Standard Gain Horn 26.4 GHz – 40.1 GHz	22240-20	Flann Microwave	468	480298
43	RF-cable No. 30	RTK 081	Rosenberger	-	410141
44	RF-cable No. 31	RTK 081	Rosenberger	-	410142
45	RF-cable 1m	KPS-1533- 400-KPS	Insulated Wire	-	480300
46	RF-cable 1m	KPS-1533- 400-KPS	Insulated Wire	-	480301
47	RF-cable 2m	KPS-1533- 400-KPS	Insulated Wire	-	480302
48	RF-cable No. 5	RTK 081	Rosenberger		410097
49	Preamplifier	JS3- 00101200- 23-5A	Miteq	681851	480337
50	Preamplifier	JS3- 12001800- 16-5A	Miteq	571667	480343
51	Preamplifier	JS3- 18002600- 20-5A	Miteq	658697	480342
52	Preamplifier	JS3- 26004000- 25-5A	Miteq	563593	480344
53	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Ancillary equipment used for testing					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
54	Power supply	TOE 8852	Toellner	51712	480233
55	Outdoor test site	-	Phoenix Test-Lab	-	480293
56	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059
57	EMI test receiver	ESPC	Rohde & Schwarz	843756/006	480150
58	Loop Antenna $\varnothing = 225$ mm	-	Phoenix Test-Lab	-	410085
59	RF-cable No. 10	RG223	Phoenix-Test-Lab	-	410102
60	AC power source / analyser	6813A	Hewlett Packard	3524A-00484	480155
61	Climatic chamber	MK 240	BINDER	05-79022	480462

All used measurement equipment was calibrated (if necessary). The calibration intervals and the calibration history will be given out on request.

TEST REPORT REFERENCE: R71209 Edition 1

9 LIST OF ANNEXES

ANNEX A	EXTERNAL PHOTOGRAPHS OF THE TEST SAMPLE:	3 pages
	IVTM ECU, top view	71209eut5.JPG
	IVTM ECU, side view	71209eut2.JPG
	IVTM ECU, 3D view	71209eut1.JPG
ANNEX B	INTERNAL PHOTOGRAPHS OF THE TEST SAMPLE:	5 pages
	IVTM ECU, enclosure opened	71209eut4.JPG
	IVTM ECU, pcb top view with shielding	71209eut8.JPG
	IVTM ECU, pcb top view shielding removed	71209eut9.JPG
	IVTM ECU, detail view radio board without shielding	71209eut3.JPG
	IVTM ECU, pcb bottom view	71209eut7.JPG
ANNEX C	PHOTOGRAPHS OF THE TEST SET-UPS:	7 pages
	IVTM ECU, testsetup anechoic chamber	71209emi3.JPG
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	IVTM ECU, testsetup open area testsite	71209emi10.JPG
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ANNEX D	RADIATED EMISSION OF THE RECEIVER	3 pages