

## EMI -- TEST REPORT

<b>Test Report No. :</b> T31018-00-02AA	07. August 2006
	Date of issue

**Type / Model Name** : TMLF-5

**Product Description** : Smart LF Oscillator System

**Applicant** : Toyota Motor Corporation

**Address** : 1, Toyota Cho

Toyota Aichi, 471-8572 Japan

**Manufacturer** : Toyota Motor Corporation

**Address** : 1, Toyota Cho

Toyota Aichi, 471-8572 Japan

**Licence holder** : Toyota Motor Corporation

**Address** : 1, Toyota Cho

Toyota Aichi, 471-8572 Japan

<b>Test Result</b> according to the standards listed in clause 1 test standards:	<b>POSITIVE</b>
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The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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## 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 15.209(a)                      Radiated emissions, general requirements

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## 2 SUMMARY

### GENERAL REMARKS:

The carrier frequency is 134.2 kHz.

The Eut consists of 1 ECU and 5 different antenna types:

- Door Antenna (DG)+Door Oscillator (DDR)
- Door Antenna (DH\_N)+Door Oscillator (DDR\_A)
- Room Antenna (RA)
- Room Antenna (RB)
- Trunk Antenna (TA)

### FINAL ASSESSMENT:

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

Date of receipt of test sample : acc. to storage records

Testing commenced on : 01. August 2006

Testing concluded on : 03. August 2006

Checked by:

Tested by:

\_\_\_\_\_  
Thomas Weise  
Dipl.-Ing.(FH)  
Laboratory Manager

\_\_\_\_\_  
Anton Altmann  
Dipl.-Ing.(FH)

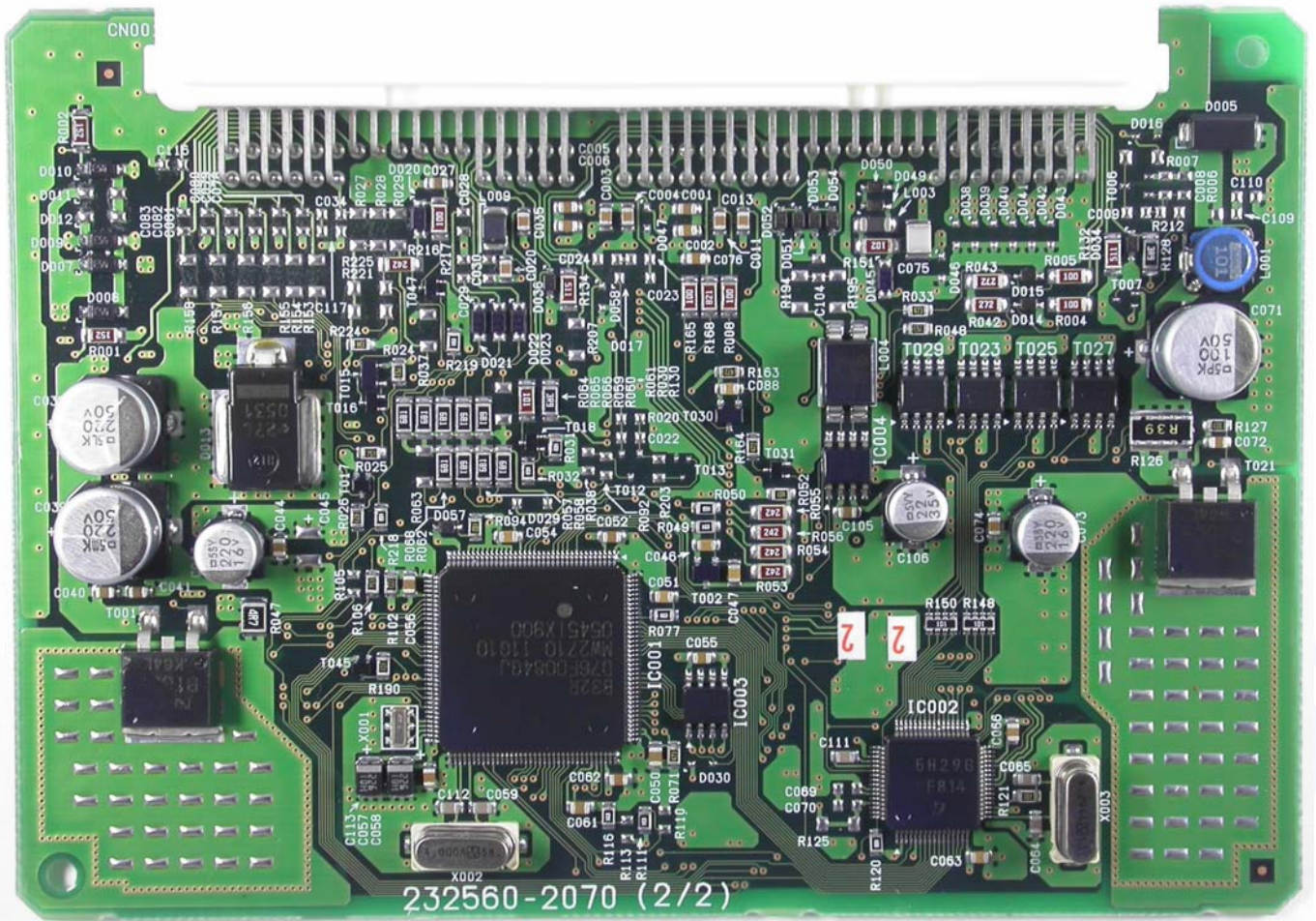
### 3 EQUIPMENT UNDER TEST

#### 3.1 Photo documentation of the EuT

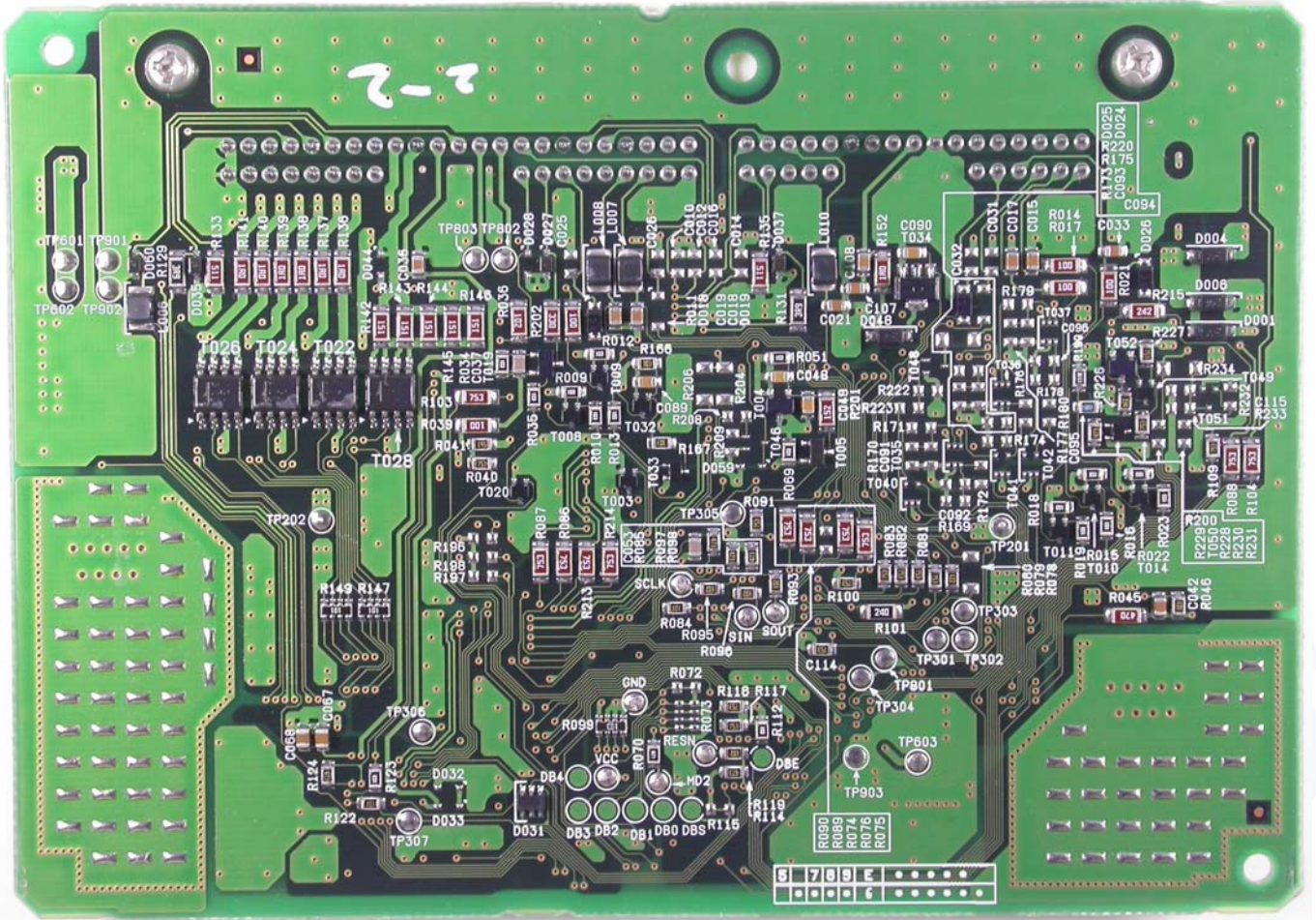
ECU



ECU



ECU



Door Antenna (DG)

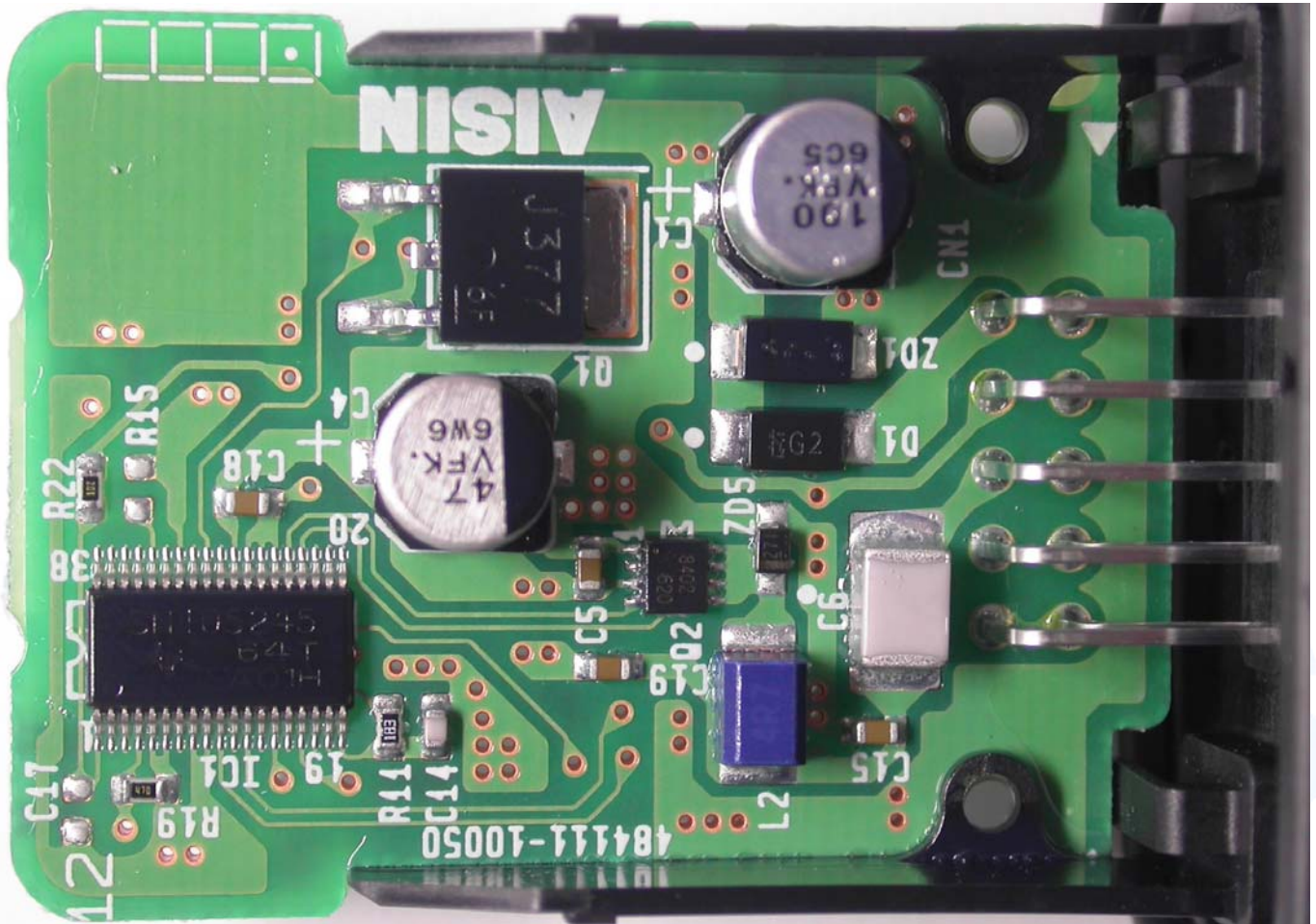




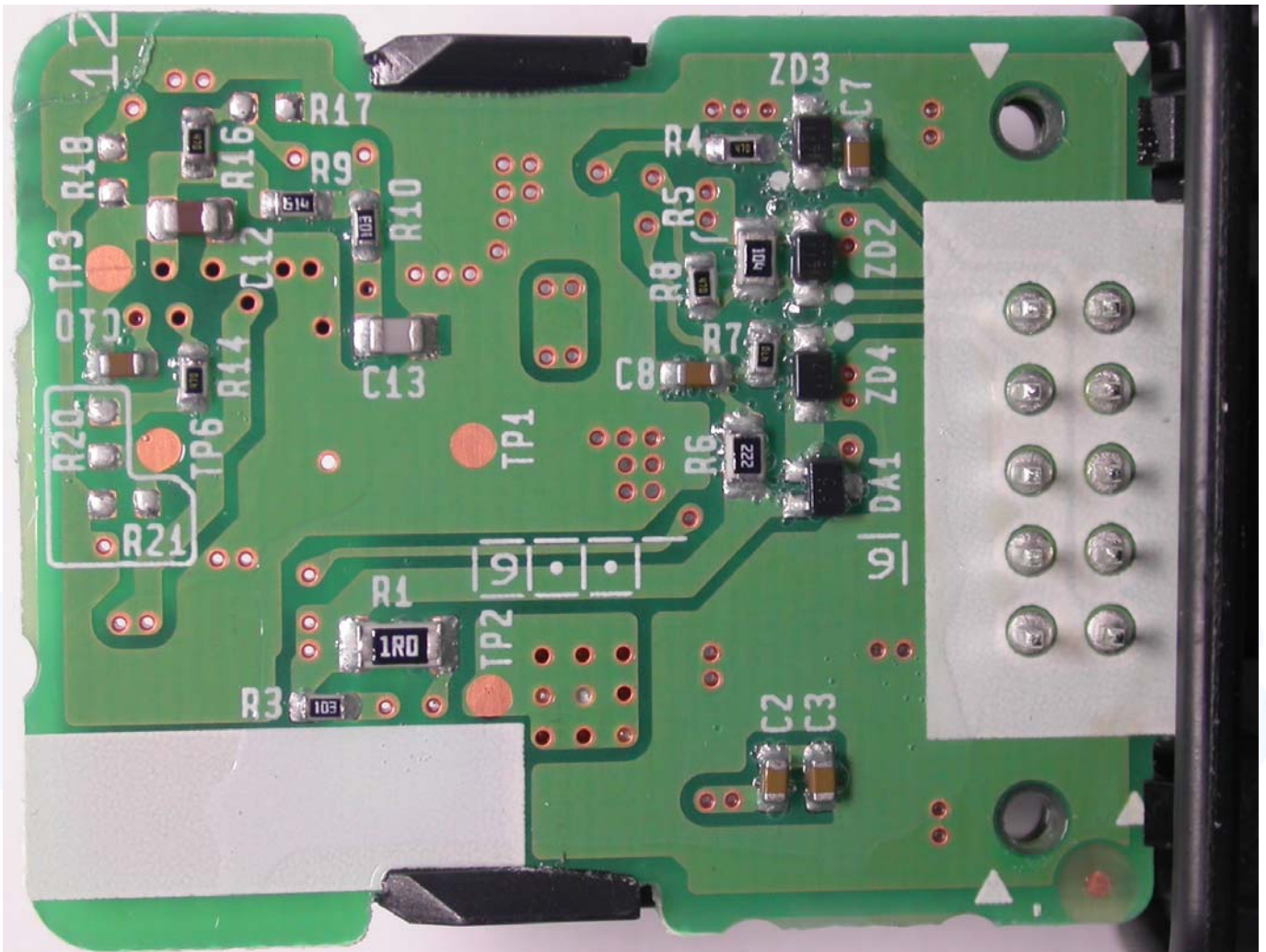
Door Oscillator (DDR)



Door Oscillator (DDR)



Door Oscillator (DDR)



Door Antenna (DH\_N)

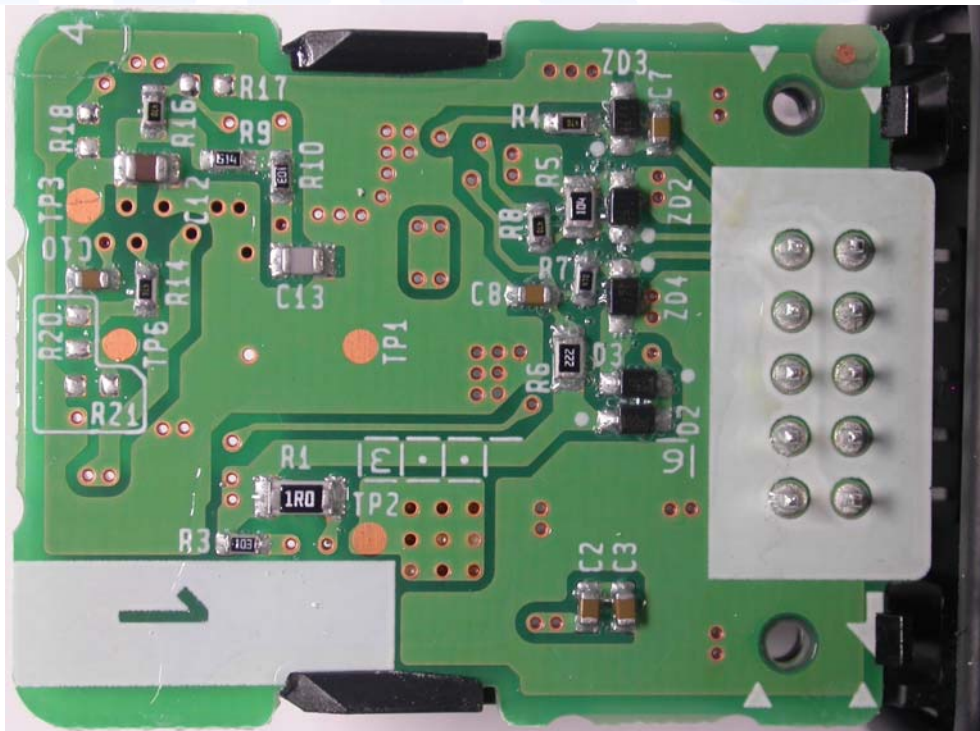
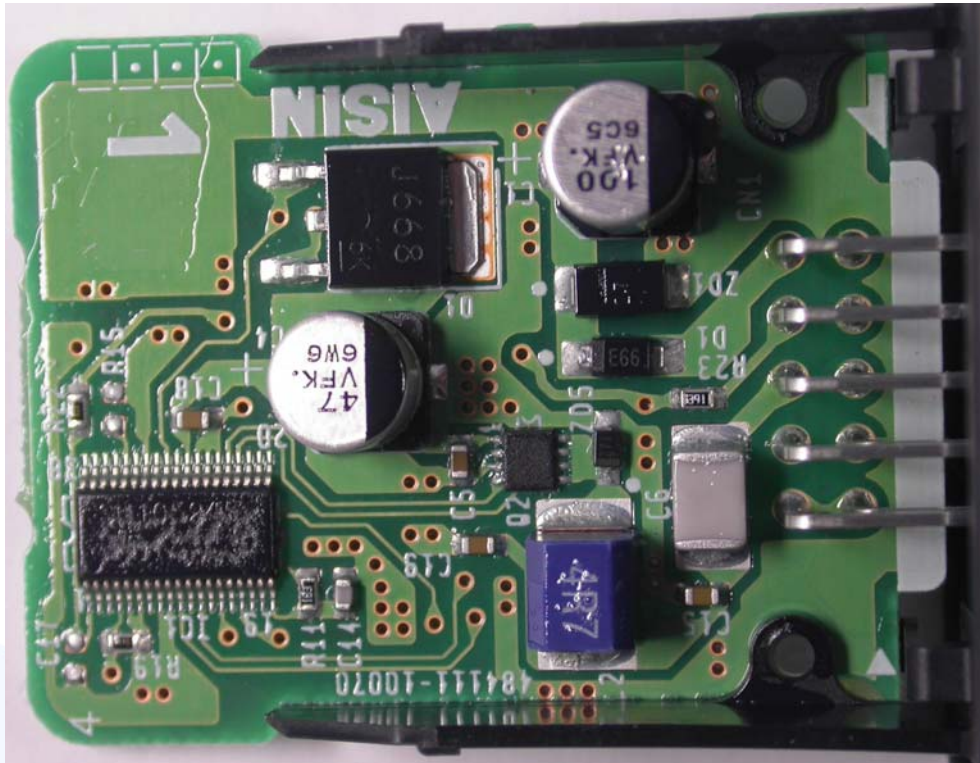


FCC ID: NI4TMLF-5

Door Oscillator (DDR\_A)

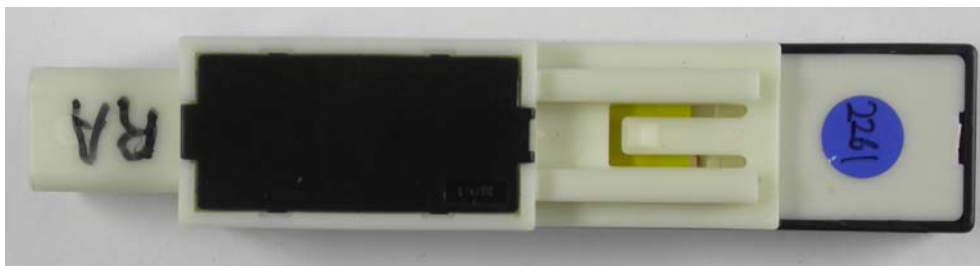


Door Oscillator (DDR\_A)

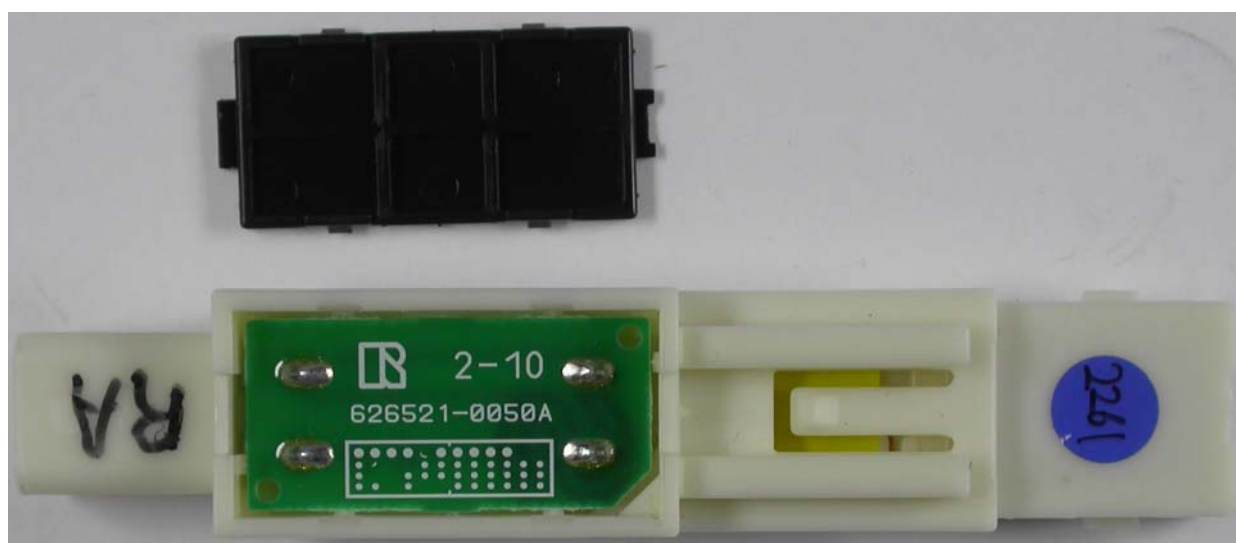


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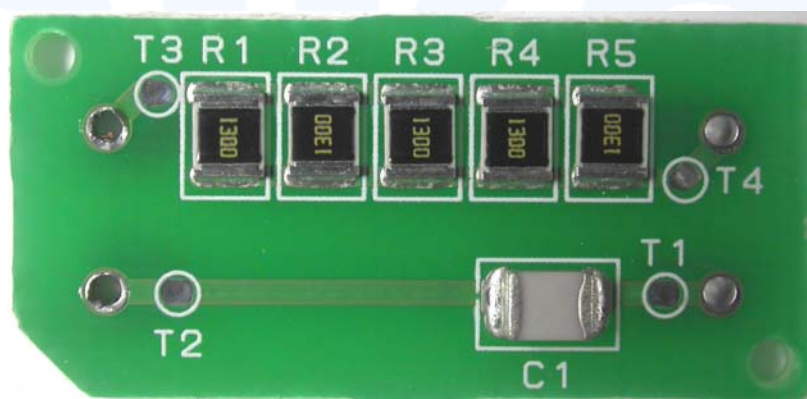
Room Antenna (RA)



Room Antenna (RA)



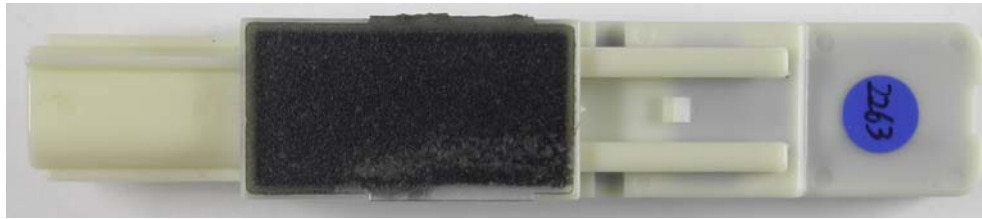
Room Antenna (RA) PCB rear view





FCC ID: NI4TMLF-5

Room Antenna (RB water-proof)

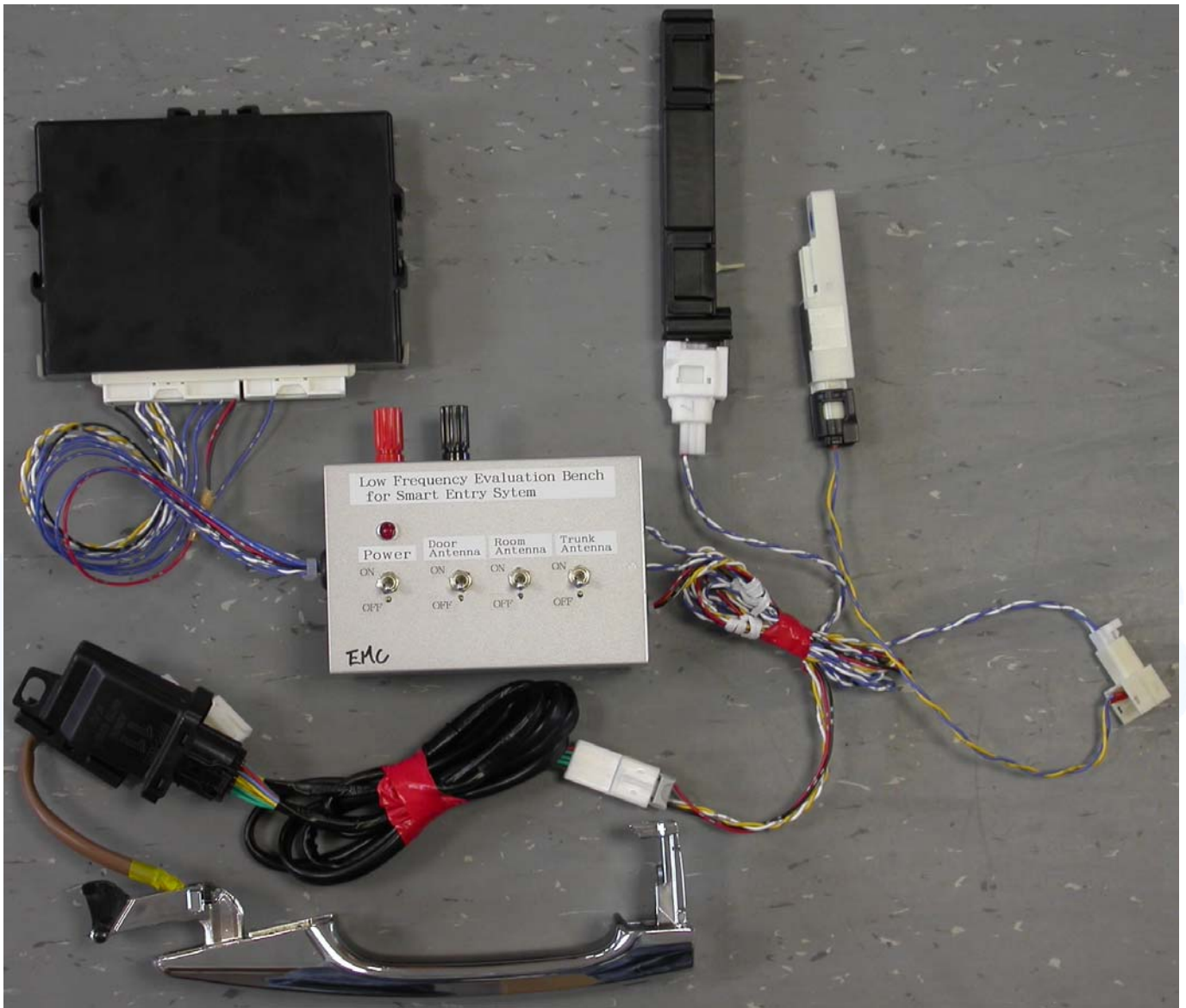


FCC ID: NI4TMLF-5

Trunk Antenna (TA)



Test box set-up



### 3.2 Power supply system utilised

Power supply voltage : 12 V / DC

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

The Smart LF Oscillator Model TMLF-5 is a transmitter that is installed in a motor vehicle and is used as part of Smart Key System. In the system, the Smart LF Oscillator mainly functions as follows:

- Smart Door Unlocking
- Smart Trunk Unlocking
- Detection of Electronic Key inside Trunk
- Smart Engine Start

The Smart LF Oscillator transmits a low frequency of 134.2 kHz through any of the installed Antennas intermittently. When a driver walks close to the doors, pushes a switch installed on the rear side, tries to lock the Trunk or goes into his motor vehicle to start the motor, the Electronic Key recognizes (receive) it and transmits a high frequency radio wave back to the motor vehicle so as to activate appropriate functions.

Number of tested samples: 1 ECU, 5 different antenna types  
Serial number: Prototype

#### EuT operation mode:

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

- Continuous transmission (unmodulated)

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- Continuous transmission (modulated)

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#### 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:

- <u>Test box</u>	Model : <u>Supplied by the manufacturer</u>
- <u>Door Antenna / Door Oscillator</u>	Model : <u>DG+DDR</u>
- <u>Door Antenna / Door Oscillator</u>	Model : <u>DH_N+DDR_A</u>
- <u>Trunk Antenna</u>	Model : <u>TA</u>
- <u>Room Antenna (non water-proof)</u>	Model : <u>RA</u>
- <u>Room Antenna (water-proof)</u>	Model : <u>RB</u>

## **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.

#### 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 its 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**

##### 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."

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## **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  $\mu$ 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. The EuT is battery powered.

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## 5.2 Field strength of the fundamental wave

For test instruments and accessories used see section 6 Part CPR 1.

### 5.2.1 Description of the test location

Test location: OATS1

Test distance: 3 metres

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





### 5.2.3 Description of Measurement

The magnetic field strength from the EuT will be measured on an open area test site in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna. The set up of the Equipment under test will be in accordance to ANSI C63.4-2003. The antenna was positioned 3, 10 or 30 meters horizontally from the EuT. Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions. In the case where larger measuring distances are required the results will 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 an EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 to 490 kHz where an average detector will be used according to Section 15.209 (d) [2].

The final level, expressed in dB $\mu$ V/m, is arrived at by taking the reading from the EMI receiver (Level dB $\mu$ V) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has to be compared with the relevant FCC limit.

The resolution bandwidth during the measurement is as follows:

9 kHz – 150 kHz: ResBW: 200 Hz

150 kHz – 30 MHz: ResBW: 9 kHz

Example:

Frequency (MHz)	Level (dB $\mu$ V)	+	Factor (dB)	=	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	=	Delta (dB)
1.705	5	+	20	=	25	30	=	5

### 5.2.4 Test result

#### a) Door Antenna (DG)/Oscillator (DDR)

Measurement distance: 3 m

Frequency [MHz]	L: PK [dB $\mu$ V]	L: AV [dB $\mu$ V]	L: QP [dB $\mu$ V]	Correct. [dB]	L: PK [dB $\mu$ V/m]	L: AV [dB $\mu$ V/m]	L: QP [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]
0.1342	75.5	75.5	75.7	20.0	95.5	95.5	95.7	105.0	-9.5

Calculated value at distance: 30 m

Frequency [MHz]	L: PK [dB $\mu$ V]	L: AV [dB $\mu$ V]	L: QP [dB $\mu$ V]	Correct. [dB]	L: PK [dB $\mu$ V/m]	L: AV [dB $\mu$ V/m]	L: QP [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]
0.1342	35.5	35.5	35.7	20.0	55.5	55.5	55.7	65.0	-9.5

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dB $\mu$ V]	L: AV [dB $\mu$ V]	L: QP [dB $\mu$ V]	Correct. [dB]	L: PK [dB $\mu$ V/m]	L: AV [dB $\mu$ V/m]	L: QP [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Delta [dB]
0.1342	-4.5	-4.5	-4.3	20.0	15.5	15.5	15.7	25.0	-9.5

b) Door Antenna (DH\_N)/Oscillator DDR\_A)

Measurement distance: 3 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	75.0	74.9	75.1	20.0	95.0	94.9	95.1	105.0	-10.1

Calculated value at distance: 30 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	35.0	34.9	35.1	20.0	55.0	54.9	55.1	65.0	-10.1

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	-5.0	-5.1	-4.9	20.0	15.0	14.9	15.1	25.0	-10.1

c) Room Antenna (RA)

Measurement distance: 3 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	75.6	75.5	75.7	20.0	95.6	95.5	95.7	105.0	-9.5

Calculated value at distance: 30 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	35.6	35.5	35.7	20.0	55.6	55.5	55.7	65.0	-9.5

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	-4.4	-4.5	-4.3	20.0	15.6	15.5	15.7	25.0	-9.5

d) Room Antenna (RB)

Measurement distance: 3 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	75.6	75.5	75.7	20.0	95.6	95.5	95.7	105.0	-9.5

Calculated value at distance: 30 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	35.6	35.5	35.7	20.0	55.6	55.5	55.7	65.0	-9.5

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	-4.4	-4.5	-4.3	20.0	15.6	15.5	15.7	25.0	-9.5

e) Trunk Antenna (TA)

Measurement distance: 3 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	76.5	76.4	76.6	20.0	96.5	96.4	96.6	105.0	-8,6

Calculated value at distance: 30 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	36.5	36.4	36.6	20.0	56.5	56.4	56.6	65	-8.6

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.1342	-3.5	-3.6	-3.4	20.0	16.5	16.4	16.6	25.0	-8.6

Limit according to FCC Part 15 Subpart 15.209(a)

Frequency (MHz)	Field strength of fundamental wave		Measurement distance (meters)
	(µV/m)	dB (µV/m)	
0.009-0.490	2400/F(kHz)	--	300
0.490-1.705	24000/F (kHz)	--	30
1.705-30.0	30	29.5	30

The requirements are **FULFILLED**.

Remarks:

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### 5.3 Spurious emissions (Magnetic field) 9 kHz – 30 MHz

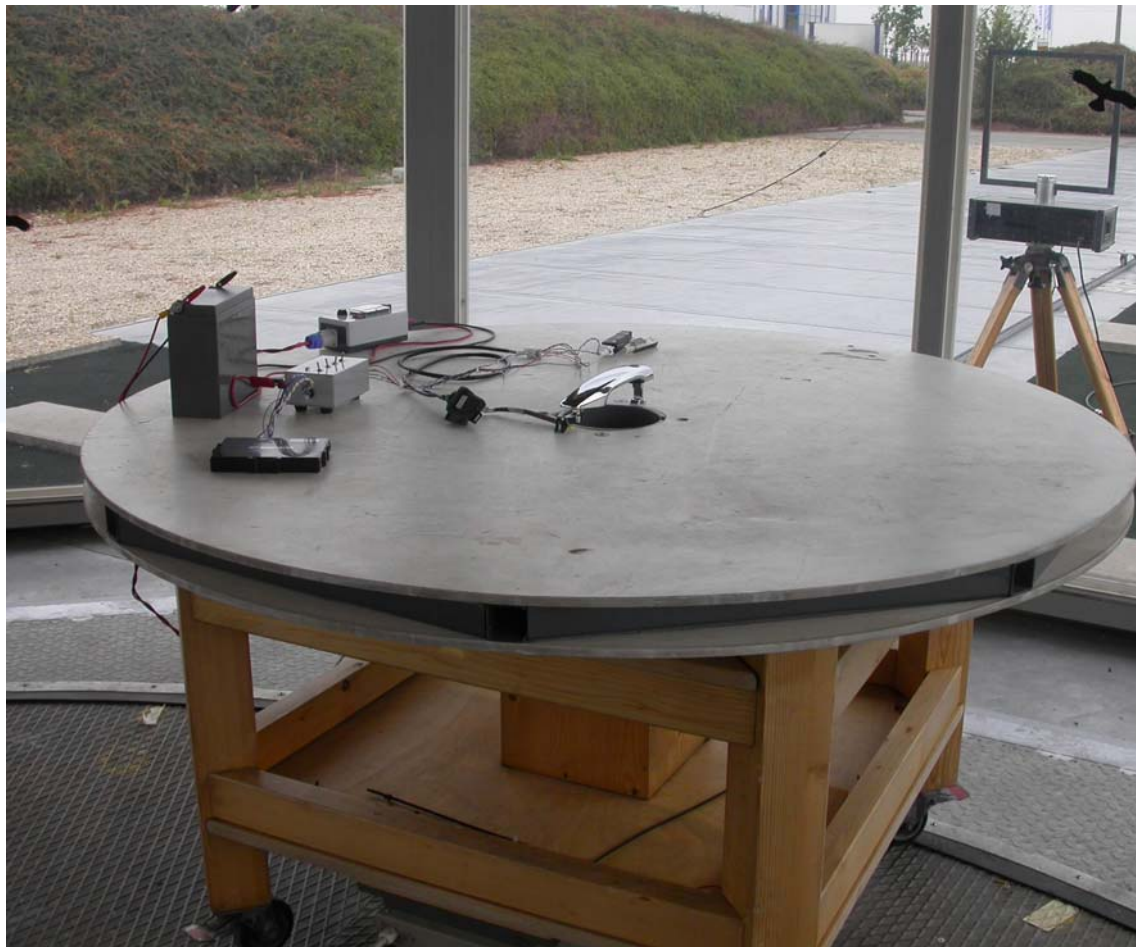
For test instruments and accessories used see section 6 Part SER 1.

#### 5.3.1 Description of the test location

Test location: OATS1

Test distance: 3 metres

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



### 5.3.3 Description of Measurement

The spurious emissions from the EuT will be measured on an open area test site in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna. The antenna was positioned 3, 10 or 30 meters horizontally from the EuT. Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions. 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 an EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 to 490 kHz where an average detector will be used according to Section 15.209 (d) [2].

The final level, expressed in dB $\mu$ V/m, is arrived at by taking the reading from the EMI receiver (Level dB $\mu$ V) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has to be compared with the relevant FCC limit.

The resolution bandwidth during the measurement is as follows:

9 kHz – 150 kHz: ResBW: 200 Hz

150 kHz – 30 MHz: ResBW: 9 kHz

Example:

Frequency (MHz)	Level (dB $\mu$ V)	+	Factor (dB)	=	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	=	Delta (dB)
1.705	5	+	20	=	25	30	=	5

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5.3.4 Test result

Trunk antenna (TA)

Measurement distance: 3 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.4026	46.8	46.7	53.1	20.0	66.8	66.7	73.1	95.5	-28.8
0.6710	37.9	37.5	43.2	20.0	57.9	57.5	63.2	71.1	-7.9
0.9394	31.8	32.3	36.5	20.0	51.8	52.3	56.5	68.1	-11.6
1.2078	27.6	27.2	31.6	20.0	47.6	47.2	51.6	66.0	-14.4

Calculated value at distance: 300 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.4026	-33.2	-33.7	-26.9	20.0	-13.2	-13.7	-6.9	15.5	-22.4

Calculated value at distance: 30 m

Frequency [MHz]	L: PK [dBµV]	L: AV [dBµV]	L: QP [dBµV]	Correct. [dB]	L: PK [dBµV/m]	L: AV [dBµV/m]	L: QP [dBµV/m]	Limit [dBµV/m]	Delta [dB]
0.6710	-2.1	-2.5	-3.2	20.0	17.9	17.5	23.2	31.1	-7.9
0.9394	-8.2	-7.7	-3.5	20.0	11.8	12.3	16.5	28.2	-11.7
1.2078	-12.4	-12.8	-8.4	20.0	7.6	7.2	11.6	26.0	-14.4

Limit according to FCC Part 15 Subpart 15.209(a)

Frequency (MHz)	Field strength of spurious emissions		Measurement distance (meters)
	(µV/m)	dB (µV/m)	
0.009-0.490	2400/F(kHz)	--	300
0.490-1.705	24000/F (kHz)	--	30
1.705-30.0	30	29.5	30

The requirements are **FULFILLED**.

**Remarks:** Measurement has been performed up to the 10<sup>th</sup> harmonic: 1.35 MHz.

All other unwanted emissions are below -15 dBµV/m (at 300 m).

This test has been performed with the Trunk antenna (TA) as the worst case (max carrier power).

## 5.4 Emission Bandwidth

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

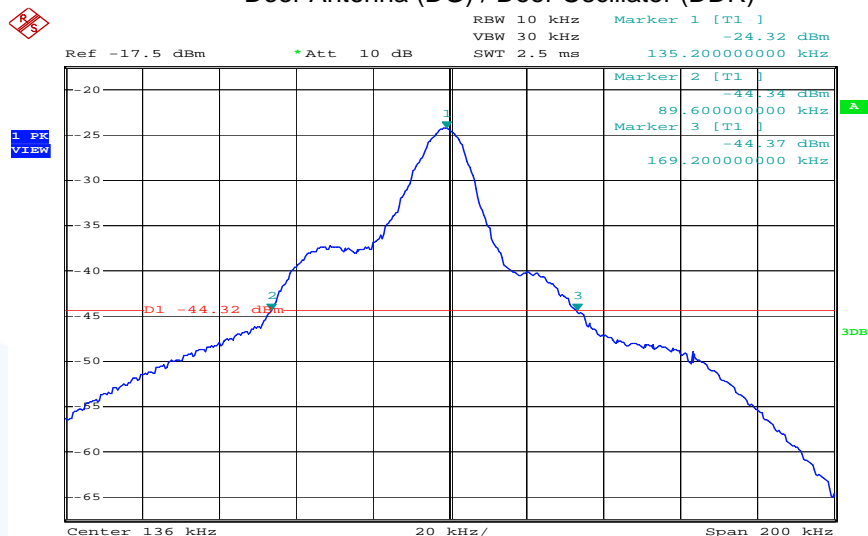
### 5.4.1 Description of the test location

Test location: AREA4

### 5.4.2 Test protocol

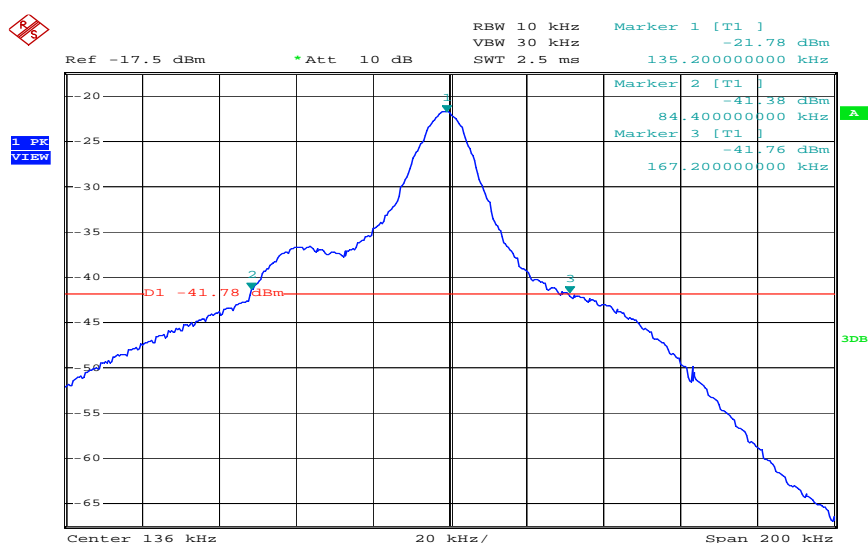
#### Emission Bandwidth plots

Door Antenna (DG) / Door Oscillator (DDR)



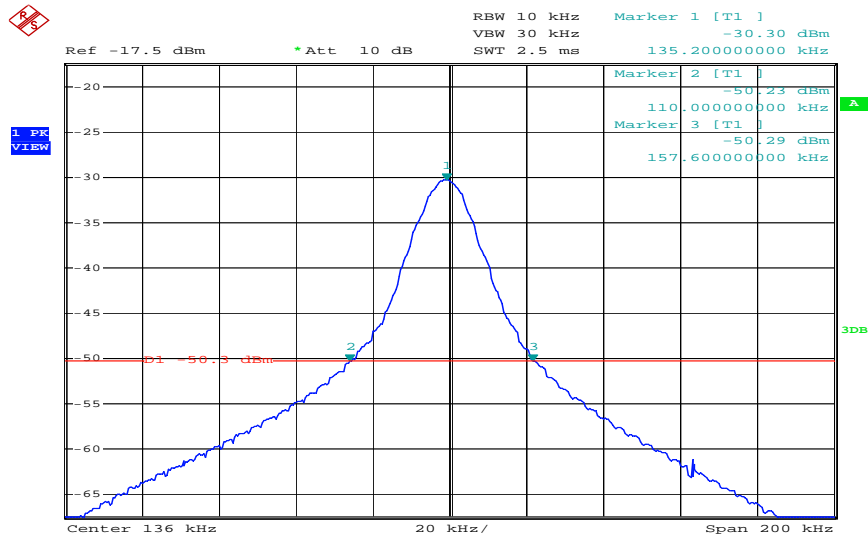
Date: 2.AUG.2006 16:17:48

Door Antenna (DH\_N) / Door Oscillator (DDR\_A)



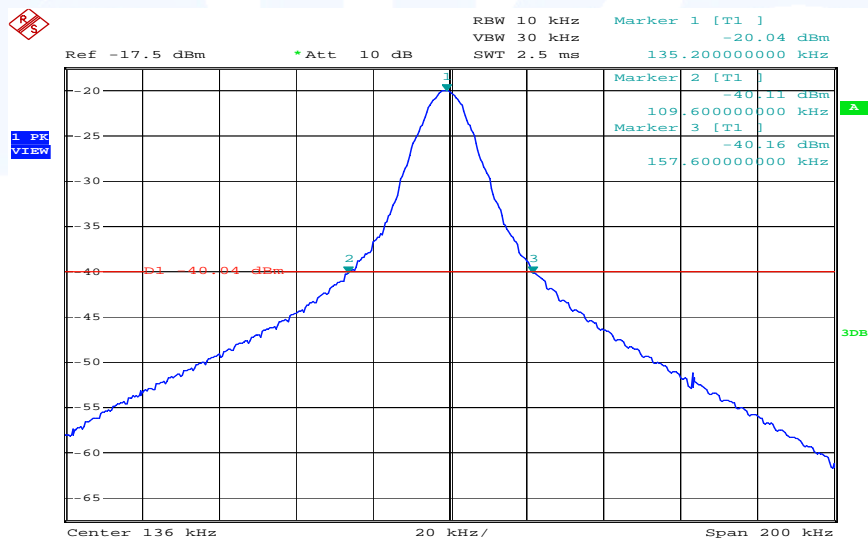
Date: 2.AUG.2006 16:16:02

Room Antenna (RA)



Date: 2.AUG.2006 16:18:54

Room Antenna (RB)



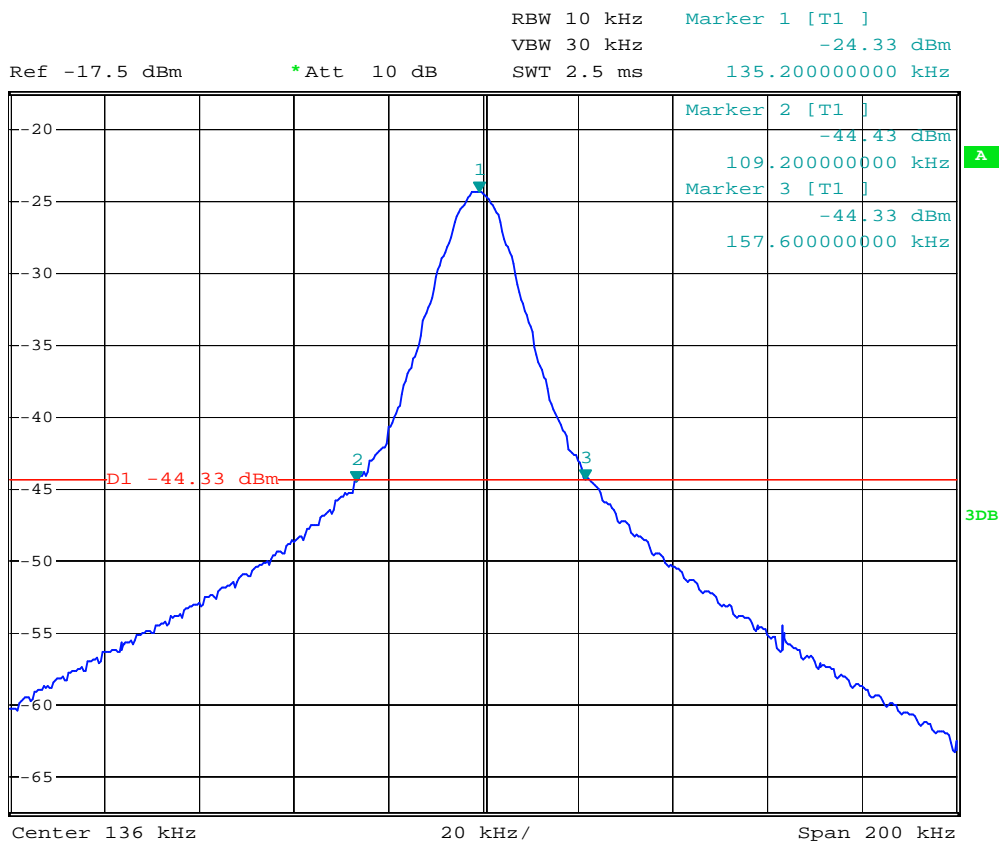
Date: 2.AUG.2006 16:19:50



Trunk Antenna (TA)



1 PK  
VIEW



Date: 2.AUG.2006 16:21:03

## 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 1	FMZB 1516	Magnetic Field Antenna	Schwarzbeck Mess-Elektronik	01-02/24-01-018
	ESCS 30	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-001
MB	ESCI	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-005
	THS730A	Handheld Scope	Tektronix GmbH	02-02/13-05-001
	HZ-10	Magnetic Field Antenna	Rohde & Schwarz München	02-02/24-05-012
	6543A	Power Supply	HP Hewelett-Packard	02-02/50-05-157
SER 1	FMZB 1516	Magnetic Field Antenna	Schwarzbeck Mess-Elektronik	01-02/24-01-018
	ESCS 30	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-001

