

CETECOM ICT Services GmbH

Radio Satellite Communication

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Test report No.: 2-4716-01-02/07

This test report consists of 49 pages

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Recognized by the
Federal Communications Commission and Industry Canada
Anechoic chamber registration No.: 90462 (FCC)
Anechoic chamber registration No.: 3463A-1 (IC)
TCB ID: DE0001



Accredited by the
German Accreditation Council
DAR-Registration Number
DAT-P-176/94-D1



Test report No.: 2-4716-01-02/07
Applicant : FUJITSU TEN LIMITED
Type : 76 GHz Milliwave Radar
Model : 271000-4040
Test standards : FCC Part 15 (06/2005) / RSS210 Issue 7
FCC ID : BAB271000404
IC ID : 2024B-271404

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1 General information

1.1 Notes

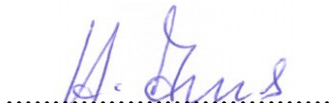
The test results of this test report relate exclusively to the test item specified in 1.5. CETECOM ICT Services GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item .

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Tester :

| Date | Name | Signature |
|------------|-------------------|---|
| 2007-10-12 | Manfred Paschwitz |  |

Technical responsibility for area of testing:

| Date | Name | Signature |
|------------|------------|---|
| 2007-10-12 | Harro Ames |  |

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1.2 Testing laboratory

CETECOM ICT Services GmbH
Untertürkheimerstraße 6–10
D-66117 Saarbrücken
Germany

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Internet : <http://www.cetecom-ict.de>

Accredited testing laboratory

Accredited by : Regulierungsbehörde für Telekommunikation und Post (RegTP)
Listed by : Federal Communications Commission (FCC)
Industry Canada (IC)

| Authority | Identification/Registration No. |
|-----------|---------------------------------|
| RegTP | DAT-P-176/94-D1 |
| FCC | 90462 |
| IC | 3463 |

Testing location, if different from CETECOM ICT Services GmbH: (Not applicable)

1.3 Details of applicant

Name : FUJITSU TEN LIMITED
Street : 2-28, Goshō-dori, 1-chome, Hyogo-ku
Town : Kobe 652-8510
Country : Japan
Telephone : +81 (0) 78-682-2094
Fax : +81 (0) 78-682-2262

Contact person

Name : Mr. Hiroshi UDA
Telephone : +81 (0) 78-682-2094
Fax : +81 (0) 78-682-2262
e-mail : hank@tm.ten.fujitsu.com

1.4 Application details

Date of receipt of application: 2007-07-30
Date of receipt of test item : 2007-10-08
Date of test : 2007-10-10 to 2007-10-12

1.5 Test item (EUT)

| | | |
|--------------------------|---|--|
| Description of test item | : | Intelligent Driver Support System / Millimeter-wave Radar |
| Type identification | : | 76 GHz Milliwave Radar |
| Model | : | 271000-4040 |
| S/N | : | 3F750012 |
| Manufacturer | : | FUJITSU TEN LIMITED 2-28, Gosho-dori, 1-chome, Hyogo-ku Kobe 652-8510 Japan |
| Telephone | : | +81 (0) 78-671-2159 |
| Fax | : | +81 (0) 78-671-7160 |
| Contact person | : | Mr. Hisanori YASUGI |
| e-mail | : | yas@ten.fujitsu.com |

1.6 Technical data

| | | |
|------------------------------------|---|--------------------------------------|
| TX frequency range | : | 76.000 – 77.000 GHz |
| TX frequency range EUT | : | 76.500 GHz – 76.605 GHz |
| Channel | : | 1 |
| Modulation | : | FM |
| Designation of Emission (ITU code) | : | QXN and P0N |
| EIRP (measured) | : | 162.2 mW (22.1 dBm) |
| Peak Power Density | : | 0.143 $\mu\text{W}/\text{cm}^2$ @ 3m |
| not-in-motion-mode | : | 8.84 pW/cm^2 @ 3m |
| Transmission time per cycle | : | 0.606 / 0.068 μs |
| Intermission time per cycle | : | 0.606 / 0.068 μs |
| Duty factor | : | 50% |
| Antenna | : | Tri-plate antenna |
| Extreme power supply U DC | : | 10.8 – 15.6 V |
| Nominal power supply U DC | : | 13.2 V |

1.6.1 Operation conditions

The sample was set in operating and in “not-in-motion”-mode via CAN-bus and a notebook with special software to simulate a moving or standing car.

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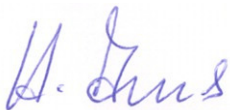
1.6.2 Test Report Cover Sheet / Performance Test Data

| | |
|--|--|
| Equipment Model Number: | 271000-4040 |
| Certification Number: | 2024B-271404 |
| Manufacturer: | FUJITSU TEN LIMITED 2-28, Goshō-dori, 1-chome, Hyogo-ku Kobe 652-8510 Japan +81 (0) 78-671-2159 +81 (0) 78-671-7160 Mr. Hisanori YASUGI yas@ten.fujitsu.com |
| Tested to Radio Standards Specification (RSS) No.: | RSS210 Issue 7 |
| Open Area Test Site Industry Canada Number: | 3463A-1 |
| Frequency Range (or fixed frequency): | 76.000GHz – 77.000 GHz |
| EIRP | 162.2 mW (22.1 dBm) |
| Peak Power Density: | 0.143 μ W/cm ² @ 3m |
| not-in-motion-mode: | 8.84 pW/cm ² @ 3m |
| Occupied Bandwidth (99% BW): | 105 MHz |
| Type of Modulation: | FMCW |
| Emission Designator (TRC-43): | 105MQXN / 105P0N |
| Transmitter Spurious (worst case): | < 500 μ V/m @ 3m |
| Receiver Spurious (worst case): | Not applicable |
| Antenna Type: | Tri-plate antenna |

ATTESTATION:

DECLARATION OF COMPLIANCE: I declare that the testing was performed or supervised by me; that the test measurements were made in accordance with the above-mentioned Industry Canada standard(s); and that the equipment identified in this application has been subjected to all the applicable test conditions specified in the Industry Canada standards and all of the requirements of the standard have been met.

Signature:



Date: 2007-10-12

Test engineer: Harro Ames

CETECOM ICT Services GmbH

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Date : 2007-10-12

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RF Technical Brief Cover Sheet according to RSS-102

1. COMPANY NUMMER : 2024B
2. CERTIFICATION NUMMER : 2024B-271404
3. MODEL NUMMER : 271000-4040
4. MANUFACTURER : 2024B
5. TYPE OF EVALUATION : RF Evaluation

| | | | |
|------------------------------------|---------------------------|-------------|---|
| Evaluated against exposure limits: | General | Public Use | X |
| | | Control Use | |
| Duty cycle used in evaluation: | 100 % | | |
| Standard used for evaluation: | RSS-102 Issue 2 (2005-11) | | |
| Measurement distance: | 0.2 m | | |
| RF value: | 0.16 W/m ² | Measured | |
| | | Computed | |
| | | Calculated | X |

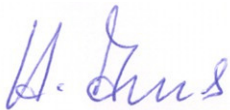
Declaration of Exposure Compliance

Attestation: I attest that the information provided above is correct; that a technical brief was prepared and the information it contains is correct; that the device evaluation was performed or supervised by me; that applicable measurement methods and evaluation methodologies have been followed and that the device meets the SAR and/or RF exposure limits of RSS-102.

Name: Harro Ames
Title: Senior Engineer
Company: CETECOM ICT Services GmbH

Date: 2007-10-12

Signature:



1.7 Test standards

Code of Federal Regulations (CFR 47)
Federal Communications Commission (FCC)

FCC Part 15 Radio Frequency Devices (06/2005)
Section 15.253
Operation within the band 76.0 to 77.0 GHz.

Section 15.209
Radiation emission limits, general requirements

Section 15.205
Restricted bands of operation.

Industry Canada
Radio Standards Specification

RSS - 210 Low Power Licence-Exempt Radio communication Devices for Cat I
equipment
Annex 13
Vehicle -Mounted Field Disturbance Sensors
RSS210 Issue 7

2 Technical test

2.1 Summary of test results

No deviations from the technical specification (s) were ascertained in the course of the performed tests.

The deviations as specified in 2.5 were ascertained in the course of the performed tests.

This test report :

describes the first test

describes an additional test

is a verification of documents

is only valid with the test report no.

2.2 Test environment

The environmental conditions are documented especially for each test.

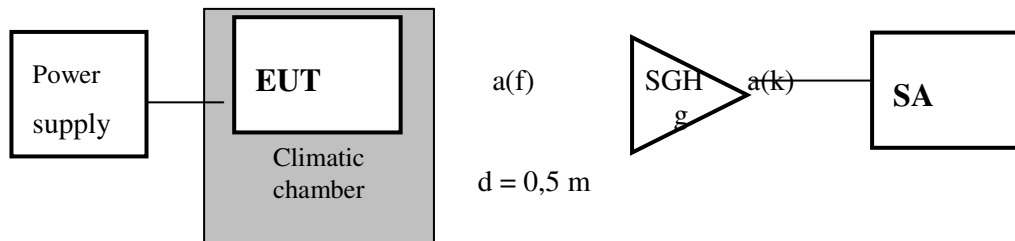
2.3 Measurement and test set-up

The measurement and test set-up is defined in the technical specification FCC part 15 Section 15.253 and IC RSS 210.

2.4 Test equipment utilized and test set-up

2.4.1 Test set-up for the measurement in the frequency range 12 GHz to 27 GHz

Spurious radiation (EIRP; PEP)



| Frequency f (GHz) | Measurement distance (m) | a(sys) [dB] | a(f) [dB] | a(k) [dB] | g [dBi] |
|-------------------|--------------------------|-------------|-----------|-----------|---------|
| 12.4 ... 18.0 | 0.5 | 34.8 | 51.6 | 1.7 | 18.4 |
| 18.0 ... 27.0 | 0.5 | 38.2 | 54.4 | 2.2 | 18.4 |
| 27.0 ... 40.0 | 0.5 | 43.6 | 57.5 | 4.5 | 18.4 |

Calculation of system attenuation = free space attenuation + cable loss - antenna gain

$$a(\text{sys}) = a(f) + a(k) - g$$

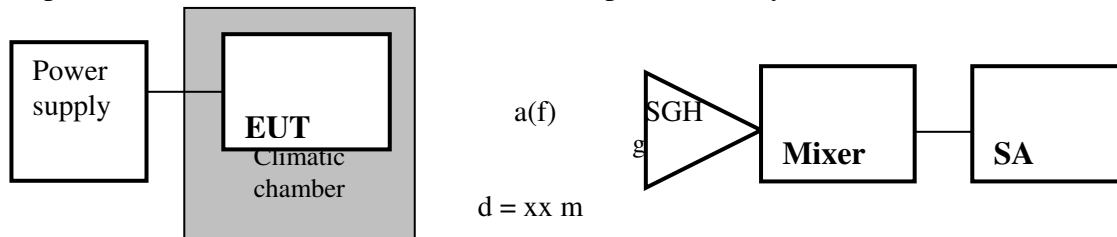
| Test equipment | Manufacturer | Type | S/No. – Cetecom No. |
|---------------------|--------------|------------|---------------------|
| Spectrum Analyser | HP | HP 8565E | 3738A00773 |
| SGH 12.4.. 18.0 GHz | narda | 639 | 300000787 |
| SGH 18 ... 27 GHz | narda | 638 | 300002442 |
| SGH 27 ... 40 GHz | narda | 637 | 300001751 |
| Power supply | HP | HP 6032A | 2848A07227 |
| Climatic chamber | Vötsch | VUK 04/500 | 522/32678 |
| RF-cable | HP | 5061-5359 | P36303 |

Measurement uncertainty

| Test parameter | Measurement uncertainty |
|------------------|-------------------------|
| Input power (DC) | ±0.1 V |
| Temperature | ±0.2 °C |
| Frequency | ±0.01 ppm |
| eirp | ±1.0 dB |

2.4.2 Test set-up for the measurement in the frequency range 27 GHz to 231 GHz

Spurious radiation (EIRP; PEP) and radiated power density (EIRP; PEP)



| Frequency f (GHz) | Measurement distance xx(m) | a(sys) [dB] | a(f) [dB]at lowest freq. | g [dBi] |
|-------------------|----------------------------|-------------|--------------------------|---------|
| 40.0 ... 60.0 | 0.5 | 33.0 | 58.5 | 25.5 |
| 60.0 ... 90.0 | 0.5 | 38.0 | 62.0 | 24.0 |
| 76.5 | 3.0 | 56.6 | 79.6 | 23.0 |
| 90.0 ... 140.0 | 0.5 | 42.0 | 65.6 | 23.6 |
| 140.0 ... 170.0 | 0.5 | 49.4 | 69.4 | 20.0 |
| 170.0 ... 250.0 | 0.5 | 52.4 | 71.1 | 18.7 |

Calculation of system attenuation = free space attenuation - antenna gain

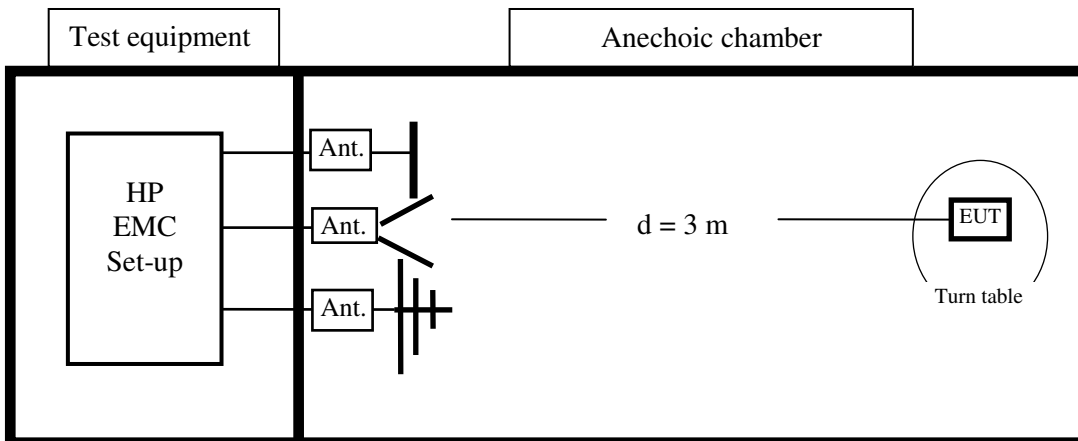
$$a(\text{sys}) = a(f) - g$$

| Test equipment | Manufacturer | Type | S/No. – Cetecom No. |
|-------------------|--------------|------------|---------------------|
| Spectrum Analyser | HP | 8565E | 3738A00773 |
| Spectrum Analyser | R&S | FSU | 1166.1660.50 |
| SGH 40 60 GHz | Flann | 2424 | 300001200g |
| Mixer 40 60 GHz | Tektronix | WM490U | 300000298b |
| SGH 50 75 GHz | HP | 2524 | 300001983 |
| Mixer 50 75 GHz | HP | 11970V | 300000081h |
| SGH 60 90 GHz | Thomson | COR 60.90 | 300000814 |
| Mixer 60 90 GHz | Tektronix | WM 780 W | B010127 |
| SGH 90 140 GHz | Thomson | COR 90-140 | 300000181 |
| Mixer 90 140 GHz | Tektronix | WM 780 F | B010129 |
| SGH 140 170 GHz | Thomson | 2924 | 300001999 |
| Mixer 140 170 GHz | Tektronix | WM780 D | B010186 |
| SGH 170 250 GHz | Thomson | 3024 | 300002001 |
| Mixer 170 250 GHz | Tektronix | WM780 J | B010241 |
| Power supply | HP | HP 6032A | 2848A07227 |
| Climatic chamber | Vötsch | VUK 04/500 | 522/32678 |
| RF-cable | HP | 5061-5359 | P36303 |

Measurement uncertainty

| Test parameter | Measurement uncertainty |
|--------------------|-------------------------|
| Input power (DC) | ±0.1 V |
| Temperature | ±0.2 °C |
| Frequency | ±0.01 ppm |
| eirp up to 110 GHz | ±1.5 dB |
| eirp up to 350 GHz | ±2.5 dB |

2.4.3 Test set-up for the measurement in the frequency range up to 12 GHz Spurious radiation



| Test equipment | Manufacturer | Type | S/No. – Cetecom No. |
|--------------------|---------------|-----------|---------------------|
| Spectrum analyser | HP | HP 85660B | 2478A05306 |
| Analyser display | HP | HP 85662A | 2816A16541 |
| Quasi peak adapter | HP | HP 85650A | 2811A01131 |
| RF-preselector | HP | HP 85685A | 2833A00768 |
| Biconical antenna | Emco | 3104 | 3758 |
| Log.-per.-antenna | Emco | 3146 | 2304 |
| Double ridge horn | Emco | 3115 | 3007 |
| Relay switch | R&S | RSU | 375 339/002 |
| High pass filter | FSY Microwave | HM 985955 | 001 |
| Amplifier | Tron-Tech | P42-GA29 | B2302 |
| Power supply | HP | HP 6038A | 2848A07027 |
| RF-cable | HP | 5061-5359 | P36303 |

Measurement uncertainties

| Test parameter | Uncertainty |
|------------------|-------------|
| Input power (DC) | ±0.1 V |
| Temperature | ±0.2 °C |
| Frequency | ±0.01 ppm |
| RF-power | ±1.5 dB |

2.5 Test results

2.5.1 Test results overview

This test was performed :

in addition to the test report no.

Verification of EUT :

EUT is in accordance with the technical description

EUT is not in accordance with the technical description

The equipment is compliant to FCC requirement

2.5.2 Remarks on methods of measurements

The Radar head is positioned in a non-conductive fixture and can be rotated and tilted in all angles.

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 9 kHz to 231 GHz in a semi-anechoic chamber, a fully-anechoic chamber and in our lab. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas conform with specifications ANSI C63.2-1996 clause 15 and ANSI C63.4-2003 clause 4.1.5. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test set-ups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received.

The wanted and unwanted emissions are received by spectrum analysers where the detector modes and resolution bandwidths (RBW) over various frequency ranges are set according to requirement ANSI C63.4-2003 clause 4.2.

1. Measurements of the EIRP and power density (PD) at fundamental frequency

The measurements are carried out according to FCC guideline "Millimetre Wave Test Procedure" with a spectrum analyser (SA), harmonic mixer with appropriate frequency range and a rectangular standard gain horn antenna (SGH) with matching wave guide dimensions. The conversion loss of the external mixer is taken into account in the SA power level reading automatically.

The radiated power measurements are performed with resolution bandwidth filter (RBW) of 1.0 MHz and a video filter of 1 MHz. This filter setting is sufficiently broad enough to receive the peak envelope power (PEP) of the EUT.

The distance for fundamental power measurement generally is 3.0 m. The SA level scale shows the dimension dBm. With a SGH and a measured antenna aperture area the power density can be calculated from the equation:

$$\begin{aligned} \text{Power density} &= \text{EIRP} / \text{Antenna aperture area} \quad [\text{mW/cm}^2] \\ \text{pd} &= \text{eirp} - a \quad [\text{dB(mW/cm}^2)] \end{aligned}$$

2. Measurements of frequency stability

In order to measure the frequency stability of the EUT under normal and extreme test conditions, it is necessary to use a smaller RBW filter (here 100 kHz or 300 kHz) so that the spectral lines of the modulated signal are displayed correctly in frequency domain. This setting allows to read the occupied bandwidth and the peak frequency deviation value directly.

Frequency measurements are performed under normal test conditions (normal power supply voltage and normal temperature).

Then the test is repeated with extreme test conditions. For extreme test conditions the EUT is placed in a climatic chamber where the front door is made of stable polystyrene. The EUT can radiate through the front door without any additional path losses. The climatic chamber together with the EUT is cooled down to -20 °C for 1 hour. Then frequency and power density measurements are carried out with power supply set to minimum and maximum values.

The climatic chamber together with the EUT is warmed up at a rate of + 1°C/minute. During warming-up time the frequency stability and the EIRP is monitored constantly. After 2 hours the temperature stability at 55 °C is reached. Then frequency and power density measurements are carried out with minimum and maximum power supply.

3. Measurements of field strength and power density at spurious frequencies

Spurious frequencies are produced by transmitter and receiver when the EUT is active (vehicle is moving). When the EUT is in Not-in-motion-mode, the emissions of the TX has to be reduced more than 25 dB. According to FCC requirements 15.209 and 15.253, spurious emissions have to be investigated as maximum field strength values in the frequency range from 9 kHz to 40 GHz, and as maximum power density in the frequency range > 40 GHz up to 231 GHz. Where possible, the measurement distance shall be 3 m.

In the low frequency range (9 kHz to 30 MHz), the receiving antenna is an active loop antenna which is positioned at 3 m distance in a shielded, anechoic chamber (see page 8). In case of required measuring distances > 3 m, a distance correction factor is used to calculate the received field strength.

Spurious field strength measurements in the frequency range 30 MHz to 12 GHz are carried out in a shielded semi-anechoic test chamber. The measurement distance is 3 m.

In the frequency range 12 GHz to 40 GHz, spurious field strength measurements are performed in a shielded fully anechoic chamber with rectangular SGH's. The measurement distances are indicated underneath each plot, and a calculation for field strength is added, where all relevant factors like cable losses, antenna factors, etc are taken into account.

In the frequency range 40 GHz to 231 GHz, spurious frequencies are measured as power densities. For further remarks see section 1.). The RBW and VBW are set to such a value that spurious power levels are clearly readable above the fundamental noise level of spectrum analyzer.

4. Measurements of maximum safe level for radiated power density

According to FCC § 1.1307, 1.1310, 2.1091, and 2.1093 and also according to ETSI/EN 301 091 measurements are carried out in order to evaluate the impact of human exposure to RF radiation. For this test the EUT is in normal operation mode.

The measurements are applicable only for far field conditions. The near field area extends to a distance of R (meters) and can be calculated from the following equation:

$$R < 2 * L^2 / \lambda$$

with R = distance in meters, L = largest dimension of either receiving or transmitting horn antenna (L = 0.02 m), and λ = wavelength in meters. In case of 76 GHz ($\lambda = 0.0039$ m), the far field starts at R > 0.205 m.

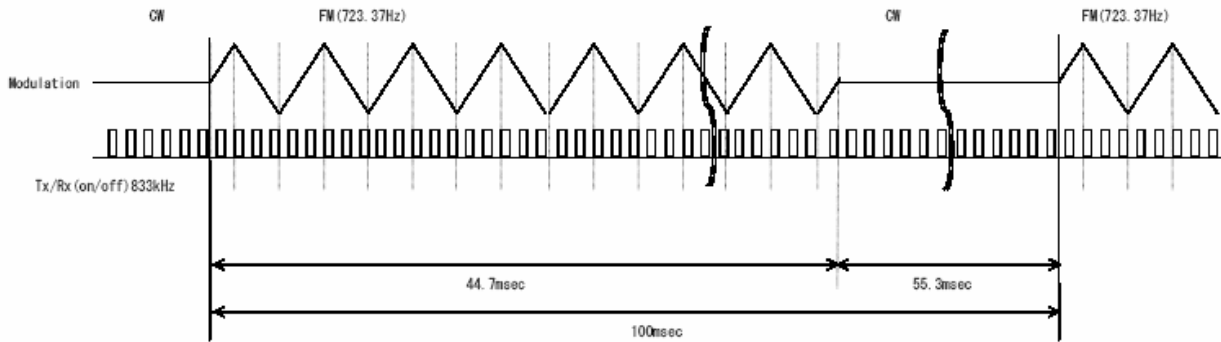
The peak power density is measured in 3 m distance as $0.143 \mu\text{W}/\text{cm}^2$.

Peak Power (EIRP)

$$\text{EIRP} = \text{PD} * 4\pi * R^2$$
$$\text{EIRP} = 162.2 \text{ mW (22.1 dBm)}$$

As the sample works with FMCW-modulation there is no difference between peak and average value of the output power.

1. Normal Mode(FM/CW)



As the output is switched on/off with 50% duty cycle, we have a correction factor of -3 dB.

So the average result is 22.1 dBm = 162.2 mW

Limit of maximum ERP for frequencies above 1.5 GHz is 3 W. See FCC § 2.1091 (EIRP = 162.2 mW)

RF Exposure for mobile conditions at **R = 0.2 m** distance from EUT

$$PD = EIRP / (4\pi * R^2)$$

$$PD = 0.016 \text{ mW/cm}^2$$

Limit of maximum permissible exposure (MPE) for uncontrolled environment: 1.0 mW/cm². See FCC § 1.1310.

2.5.3 Test results in details

Equipment under test (EUT) : 271000-4040
 Ambient temperature : 23 °C
 Relative humidity : 35 %

TRANSMITTER PARAMETERS

SECTION 15.253

FUNDAMENTAL FREQUENCY

SECTION 15.253 b (2)

76.000 GHz to 77.000 GHz

Operation : Vehicle in-motion-mode
 Antenna assembly: integrated antennas (mechanical scanning)

| TEST CONDITIONS T = 23.0 °C | TRANSMITTER POWER DENSITY | | |
|-----------------------------------|---------------------------|---|---------------------|
| EUT operating: TX on and RX on | Frequency f [GHz] | Power Density PD [$\mu\text{W}/\text{cm}^2$] | See plot on page |
| U DC = 10.0 V | 76.552 | 0.143 | |
| U DC = 11.0 V | 76.552 | 0.143 | |
| U DC = 12.0 V | 76.552 | 0.143 | 24 |
| U DC = 13.0 V | 76.552 | 0.143 | |
| U DC = 14.0 V | 76.552 | 0.143 | |
| U DC = 15.0 V | 76.552 | 0.143 | |
| U DC = 16.0 V | 76.552 | 0.143 | |

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 10

LIMITS:

SECTION 15.253 b (2)

| Frequency range [GHz] vehicle in motion | Measurement distance [m] | Power density pd [dBmW/cm ²] | Power Density PD [$\mu\text{W}/\text{cm}^2$] |
|--|-----------------------------|---|---|
| 76.0 to 77.0 | 3.0 | -12.2 | 60 |

Verdict : Power Density limit is kept

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Equipment under test (EUT) : 271000-4040
Ambient temperature : 23 °C
Relative humidity : 35 %

TRANSMITTER PARAMETERS

SECTION 15.253

FUNDAMENTAL FREQUENCY

SECTION 15.253 b (2)

76.000 GHz to 77.000 GHz

Operation : Vehicle in-motion-mode
Antenna assembly: integrated antennas (mechanical scanning)

| TEST CONDITIONS T = - 20.0 ° C | TRANSMITTER POWER DENSITY | |
|-----------------------------------|---------------------------|---|
| EUT operating: TX on and RX on | Frequency f [GHz] | Power Density PD [$\mu\text{W}/\text{cm}^2$] |
| U DC = 10.0 V | 76.575 | 0.172 |
| U DC = 11.0 V | 76.575 | 0.172 |
| U DC = 12.0 V | 76.575 | 0.172 |
| U DC = 13.0 V | 76.575 | 0.172 |
| U DC = 14.0 V | 76.575 | 0.172 |
| U DC = 15.0 V | 76.575 | 0.172 |
| U DC = 16.0 V | 76.575 | 0.172 |

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 10

LIMITS:

SECTION 15.253 b (2)

| Frequency range [GHz] vehicle in motion | Measurement distance [m] | Power density pd [dBmW/cm ²] | Power Density PD [$\mu\text{W}/\text{cm}^2$] |
|--|-----------------------------|---|---|
| 76.0 to 77.0 | 3.0 | -12.2 | 60 |

Verdict : Power Density limit is kept

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Equipment under test (EUT) : 271000-4040
Ambient temperature : 23 °C
Relative humidity : 35 %

TRANSMITTER PARAMETERS

SECTION 15.253

FUNDAMENTAL FREQUENCY

SECTION 15.253 b (2)

76.000 GHz to 77.000 GHz

Operation : Vehicle in-motion-mode
Antenna assembly: integrated antennas (mechanical scanning)

| TEST CONDITIONS T = + 55.0 ° C | TRANSMITTER POWER DENSITY | |
|-----------------------------------|---------------------------|---|
| EUT operating: TX on and RX on | Frequency f [GHz] | Power Density PD [$\mu\text{W}/\text{cm}^2$] |
| U DC = 10.0 V | 76.515 | 0.137 |
| U DC = 11.0 V | 76.515 | 0.137 |
| U DC = 12.0 V | 76.515 | 0.137 |
| U DC = 13.0 V | 76.515 | 0.137 |
| U DC = 14.0 V | 76.515 | 0.137 |
| U DC = 15.0 V | 76.515 | 0.137 |
| U DC = 16.0 V | 76.515 | 0.137 |

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 10

LIMITS:

SECTION 15.253 b (2)

| Frequency range [GHz] vehicle in motion | Measurement distance [m] | Power density pd [dBmW/cm ²] | Power Density PD [$\mu\text{W}/\text{cm}^2$] |
|--|-----------------------------|---|---|
| 76.0 to 77.0 | 3.0 | -12.2 | 60 |

Verdict : Power Density limit is kept

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Equipment under test (EUT) : 271000-4040
Ambient temperature : 23 °C
Relative humidity : 35 %

TRANSMITTER PARAMETERS

SECTION 15.253

FUNDAMENTAL FREQUENCY

SECTION 15.253 b (2)

Frequency over temperature

Occupied frequency range:

| TEST CONDITIONS T = -20° TO +55°C 12V DC | TRANSMITTER POWER DENSITY AND FREQUENCY | | |
|--|---|---|---------|
| EUT operating: | Frequency f [GHz] | Power Density PD [$\mu\text{W}/\text{cm}^2$] | |
| T = -20° | 76.575 | 0.172 | |
| T = -10° | 76.573 | 0.162 | |
| T = 0° | 76.561 | 0.153 | |
| T = +10° | 76.557 | 0.147 | |
| T = +20° | 76.552 | 0.143 | 37 / 38 |
| T = +30° | 76.537 | 0.141 | |
| T = +40° | 76.527 | 0.140 | |
| T = +50° | 76.520 | 0.139 | |
| T = +55° | 76.515 | 0.137 | |

Verdict : Frequency tolerance limits are kept

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EUT : 271000-4040
Ambient temperature : 23 °C
Relative humidity : 35 %

TRANSMITTER PARAMETERS

SECTION 15.253

SPURIOUS EMISSIONS

SECTION 15.209

In the frequency range 9 kHz to 12 GHz

Operation : Vehicle in-motion-mode
Antenna assembly: integrated antennas (mechanical scanning)

| TEST CONDITIONS | TRANSMITTER SPURIOUS FIELD STRENGTH | | | |
|---|-------------------------------------|----------------------|----------------|------------------|
| Frequency range [MHz] | Spurious frequencies [MHz] | S A e [dB μ V/m] | E [μ V/m] | See plot on page |
| 0.009 – 30.000 (h + v) horizontal and vertical plane | Noise | < limit | < limit | 25 |
| 30.000 – 1.0 GHz (h + v) | Noise | < limit | < limit | 26 |
| 1.0 – 4.0 GHz (h + v) | Noise | < limit | < limit | 27 |
| 4.0 – 12.0 GHz (h + v) | Noise | < limit | < limit | 28 |

REFERENCE OF TEST EQUIPMENT USED : see test set-up on pages 9, 10 and 11

LIMITS: SECTION 15.253 / 15.205 / 15.209

| Frequency range (MHz) | Measurement distance [m] | Field strength e [dB μ V/m] @ 3 m | Field strength E [μ V/m] |
|-----------------------|--------------------------|---------------------------------------|-------------------------------|
| 0.009 – 0.490 | 300 | 88.5 ... 53.8 | 2400/F(kHz) |
| 0.490 – 1.705 | 30 | 53.8 ... 43.0 | 24000/F(kHz) |
| 1.705 – 30.0 | 30 | 49.5 | 30 |
| 30.0 – 88.0 | 3 | 40.0 | 100 |
| 88.0 – 216.0 | 3 | 43.5 | 150 |
| 216.0 – 960.0 | 3 | 46.0 | 200 |
| 960.0 MHz – 40.0 GHz | 3 | 54.0 | 500 |

Verdict : Field strength limits are kept

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EUT : 271000-4040
Ambient temperature : 23 °C
Relative humidity : 35 %

TRANSMITTER PARAMETERS

SECTION 15.253

SPURIOUS EMISSIONS

SECTION 15.209

In the frequency range 12 GHz to 40 GHz

Operation : Vehicle in-motion-mode
Antenna assembly: integrated antennas (mechanical scanning)

| TEST CONDITIONS | TRANSMITTER SPURIOUS FIELD STRENGTH | | | |
|--|-------------------------------------|----------------------|----------------|------------------|
| Frequency range [GHz] | Spurious frequencies [GHz] | S A e [dB μ V/m] | E [μ V/m] | See plot on page |
| 12.0 – 18.0 (h + v) horizontal and vertical plane | Noise | < limit | < limit | 29 |
| 18.0 – 27.0 (h + v) | Noise | < limit | < limit | 30 |
| 27.0 – 40.0 (h + v) | Noise | < limit | < limit | 31 |

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 9, 10 and 11

LIMITS: SECTION 15.253 / 15.205 / 15.209

| Frequency range (MHz) | Measurement distance [m] | Field strength e [dB μ V/m] @ 3 m | Field strength E [μ V/m] |
|-----------------------|--------------------------|---------------------------------------|-------------------------------|
| 0.009 – 0.490 | 300 | 88.5 ... 53.8 | 2400/F(kHz) |
| 0.490 – 1.705 | 30 | 53.8 ... 43.0 | 24000/F(kHz) |
| 1.705 – 30.0 | 30 | 49.5 | 30 |
| 30.0 – 88.0 | 3 | 40.0 | 100 |
| 88.0 – 216.0 | 3 | 43.5 | 150 |
| 216.0 – 960.0 | 3 | 46.0 | 200 |
| 960.0 MHz – 40.0 GHz | 3 | 54.0 | 500 |

Verdict : Field strength limits are kept

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EUT : 271000-4040
Ambient temperature : 23 °C
Relative humidity : 35 %

TRANSMITTER PARAMETERS

SECTION 15.253

SPURIOUS EMISSIONS

SECTION 15.253 c (2) + (3)

In the frequency range 40 GHz to 231 GHz

Operation : Vehicle in-motion-mode
Antenna assembly: integrated antennas (mechanical scanning)

| TEST CONDITIONS | | TRANSMITTER SPURIOUS POWER DENSITY | | | |
|-----------------------|---------|------------------------------------|-------------------------------|--------------------------|------------------|
| Frequency range [GHz] | | Spurious frequencies [GHz] | S A pd [dBm/cm ²] | PD [pW/cm ²] | See plot on page |
| 40.0 – 50.0 | (h + v) | Noise | < limit | < limit | 32 |
| 50.0 – 75.0 | (h + v) | Noise | < limit | < limit | 33 |
| 75.0 - 110.0 | (h + v) | Noise | < limit | < limit | 34 |
| 110.0 - 170.0 | (h + v) | Noise | < limit | < limit | 35 |
| 170.0 - 231.0 | (h + v) | Noise | < limit | < limit | 36 |

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 9, 10 and 11

LIMITS:

SECTION 15.253 / 15.205 / 15.209

| Frequency range (MHz) | Measurement distance [m] | pd [dBmW/cm ²] | Power density PD [pW/cm ²] |
|-----------------------|--------------------------|----------------------------|--|
| 40.0 GHz - 200 GHz | 3.0 | -62.2 | 600 |
| 200 GHz - 231 GHz | 3.0 | -60.0 | 1000 |

Verdict : Power density limits are kept

EUT : 271000-4040
Ambient temperature : 23 °C
Relative humidity : 38 %

2.5.4 Not-In-motion Mode (1)

SECTION 15.253 (b)

To show compliance with the requirements of Part 15.253 (b) (1) – Not-In-Motion mode, we tested with a can-bus interface on a laptop with special software to simulate moving or not-moving of the car.

Description of the test:

We placed the antenna 25 cm in front of the radar equipment with vertical polarisation to obtain max. power.
We started the simulation on the PC.

Here we switched the simulation to TX/RX Off mode (not in motion simulation).

The maximum power density in not-in-motion-mode is 8.84 pW/cm² (see next plot).

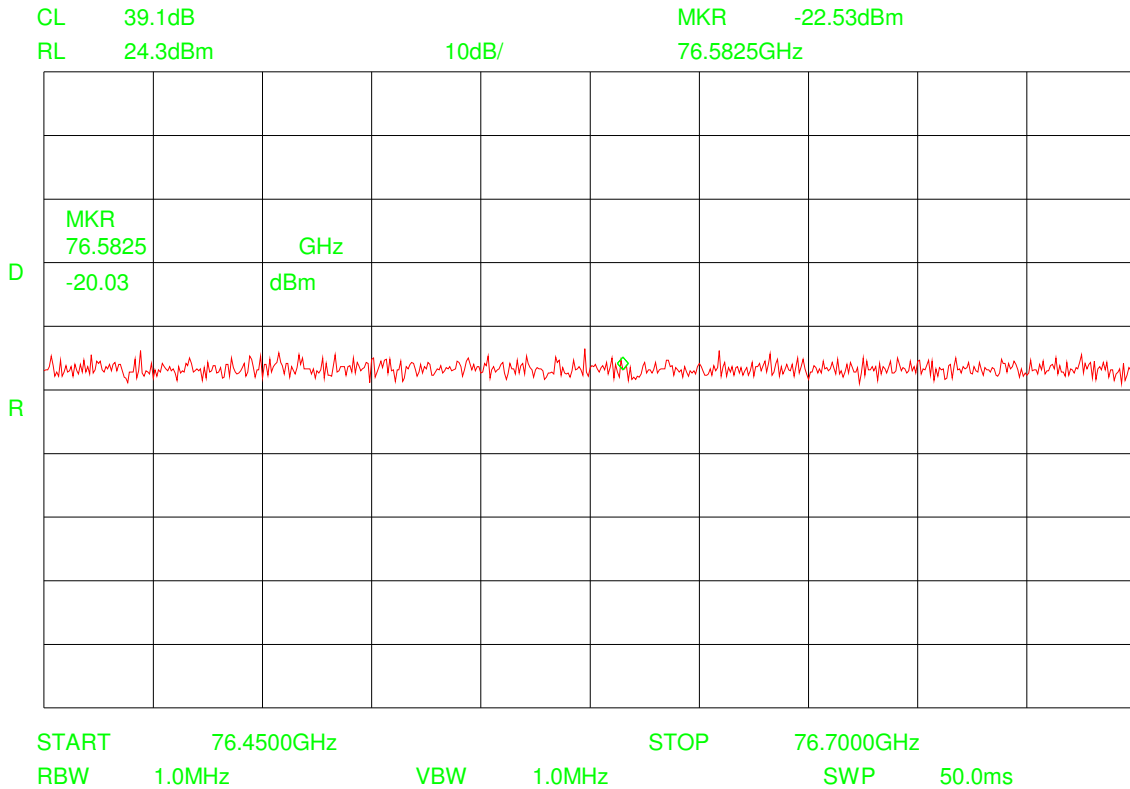
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Plot: not-in-motion-mode



Measurement distance $d = 0.25 \text{ m}$

Calculation of system attenuation = free space attenuation - antenna gain
 $a(\text{sys}) = 58.2 \text{ dB} - 23.0 \text{ dB}$
 $= 35.2 \text{ dB}$

The $a(\text{sys})$ is calculated in the Analyser reading.

Output power = $10 \mu\text{W}$ (-20.0 dBm)

Calculation :

Power density = $\text{EIRP (mW)} / 4 * \text{Pi} * 300\text{cm} * 300\text{cm}$
 $= 10 \mu\text{W} (-20.0 \text{ dBm}) / 1130973.4 \text{ cm}^2$

Peak Power density = 8.84 pW/cm^2

LIMITS:

SECTION 15.253 (B) (1)

| Frequency range [GHz] | Measurement distance [m] | Not-in-motion [dBm/cm ²] [nW/cm ²] |
|-----------------------|--------------------------|--|
| 76.0 - 77.0 | 3.0 | -37 200 |

Verdict : pass

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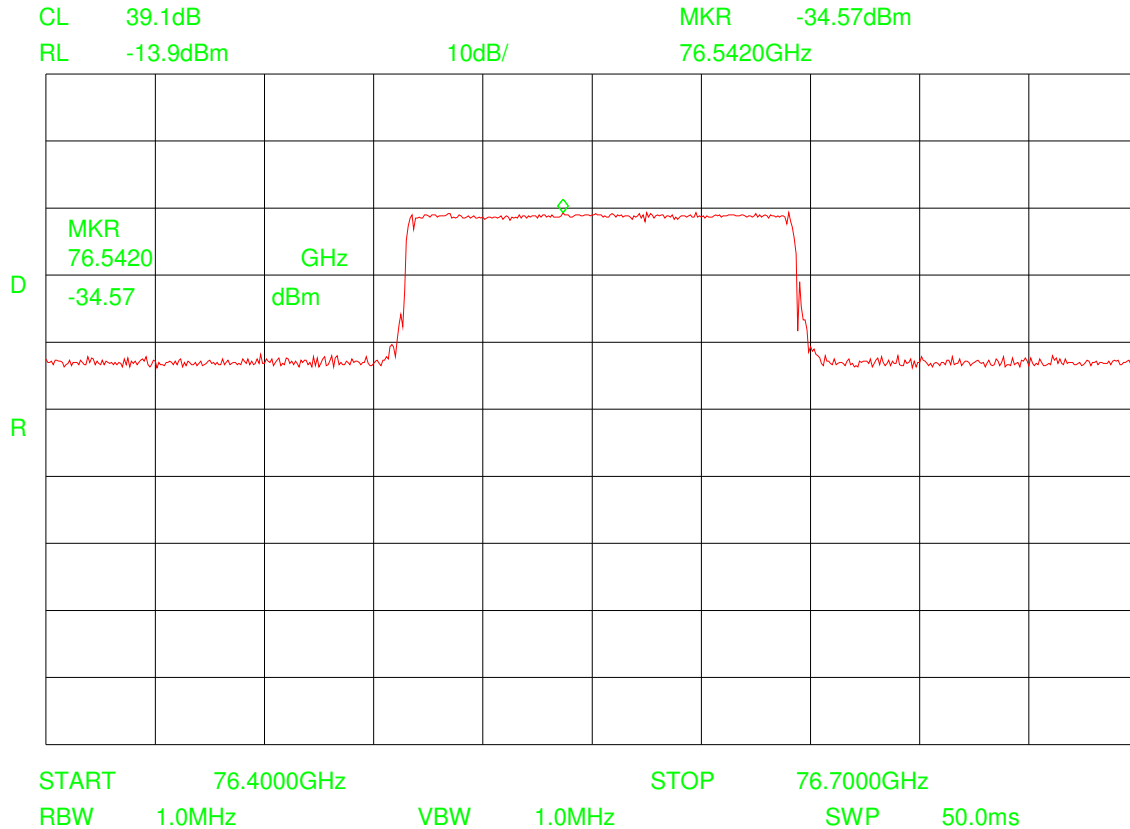
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3 Plots, graphs and data sheets

Plot no.: 1



Measurement distance $d = 3.0 \text{ m}$

Calculation of system attenuation = free space attenuation - antenna gain

$a(\text{sys}) \quad 3.0 \text{ m distance} = 79.6 \text{ dB} - 23.0 \text{ dB}$
 $= 56.6 \text{ dB}$

Calculation:

Output power $= -34.5 \text{ dBm} + 56.6 \text{ dB} = 22.1 \text{ dBm} = 162.2 \text{ mW}$

Power density $= \text{EIRP (mW)} / 4 * \text{Pi} * 300\text{cm} * 300\text{cm}$
 $= 162.2 \text{ mW (22.1 dBm)} / 1130973.4 \text{ cm}^2$

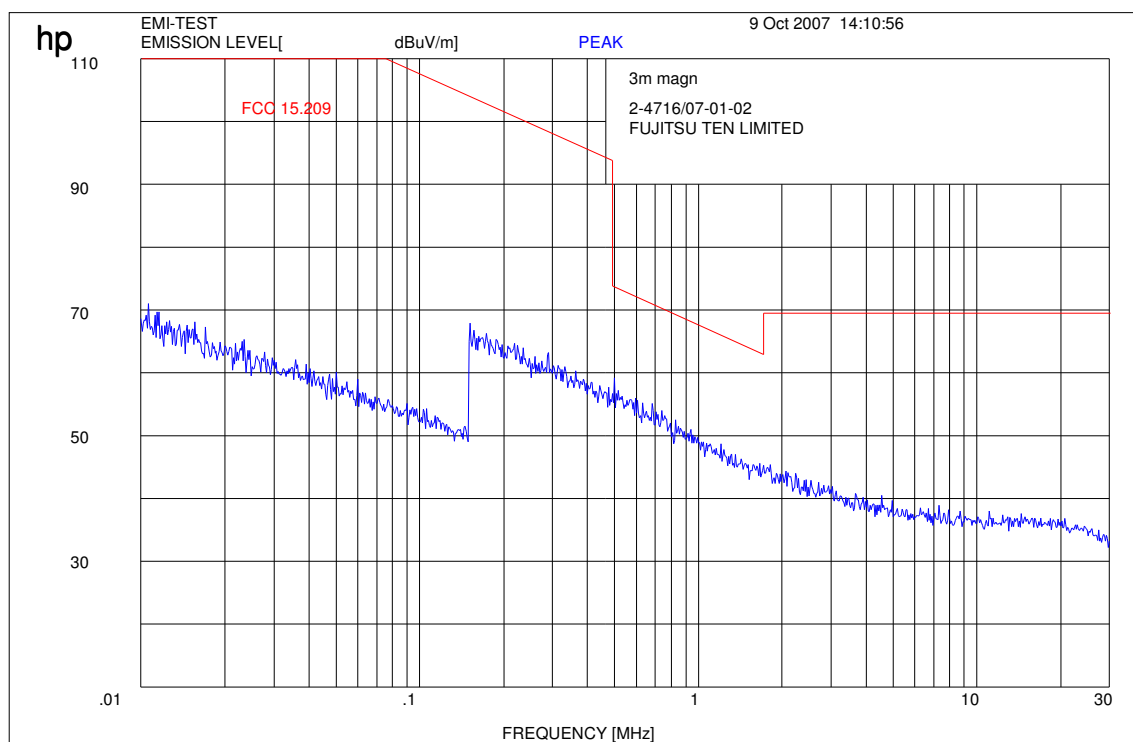
Peak Power density $= 0.143 \mu\text{W/cm}^2$

Limit $= 60 \mu\text{W/cm}^2 \text{ at } 3.0 \text{ m}$

| | |
|-----------|------|
| Verdict : | pass |
|-----------|------|

Plot no.: 2

Radiated emissions 9 kHz to 30 MHz



Settings:

RBW/VBW : 200 Hz up to 150 kHz,
9 kHz up to 30 MHz,

The correction is calculated by the measuring system.

Verdict : pass

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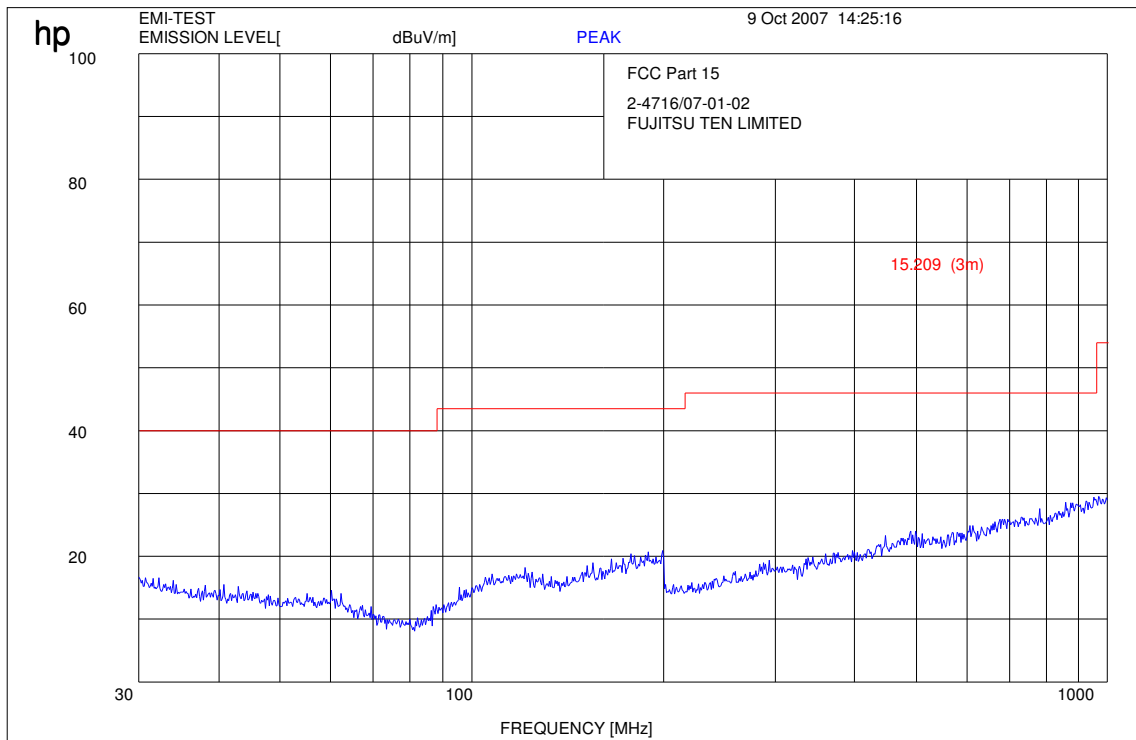
Test report No.: 2-4716-01-02/07

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Plot no.: 3

Radiated emissions 30 MHz to 1 GHz



Settings:

RBW/VBW : 120 kHz up to 1 GHz ,

The correction is calculated by the measuring system.

Verdict : pass

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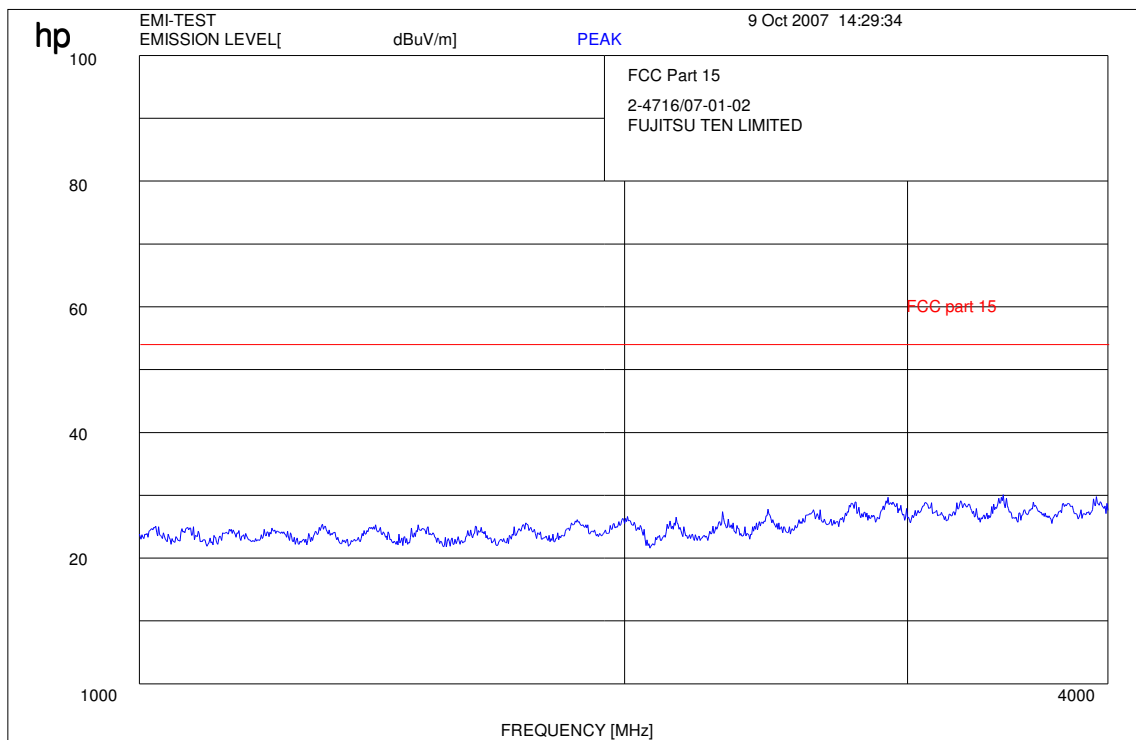
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Plot no.: 4

Radiated emissions 1 GHz to 4 GHz



Settings:

RBW/VBW : 1 MHz above 1 GHz

The correction is calculated by the measuring system.

Verdict : pass

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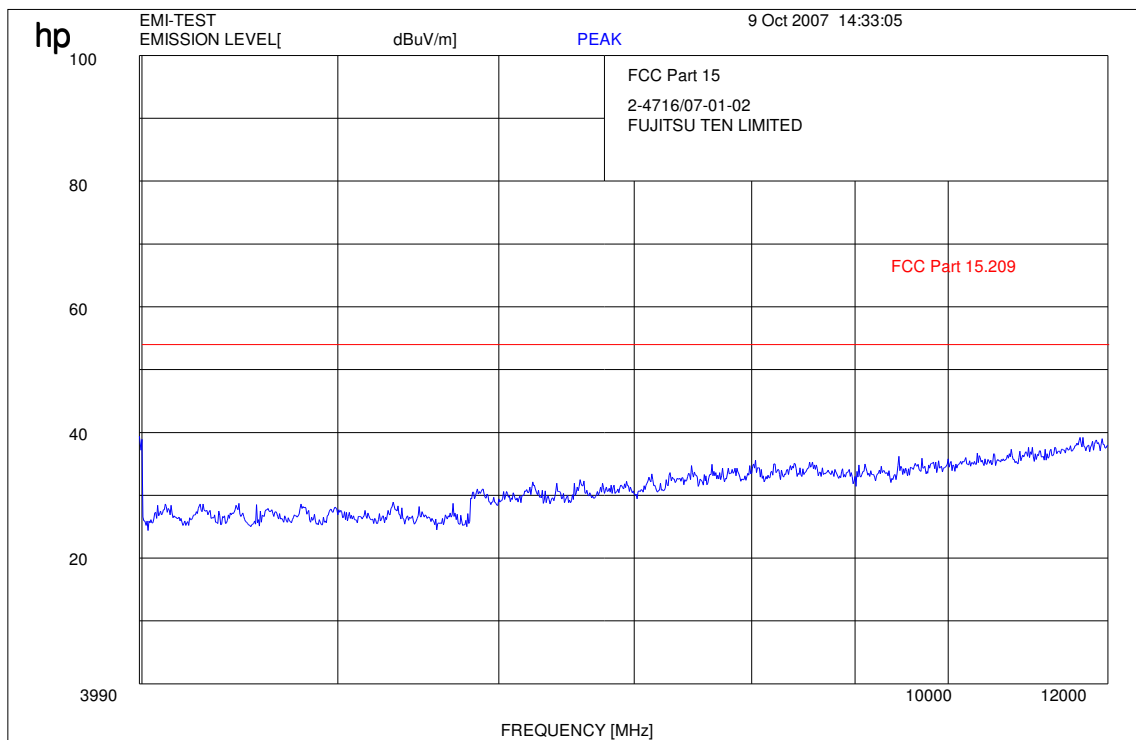
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Plot no.: 5

Radiated emissions 4 GHz to 12 GHz



Settings:

RBW/VBW : 1 MHz above 1 GHz

The correction is calculated by the measuring system.

Verdict : pass

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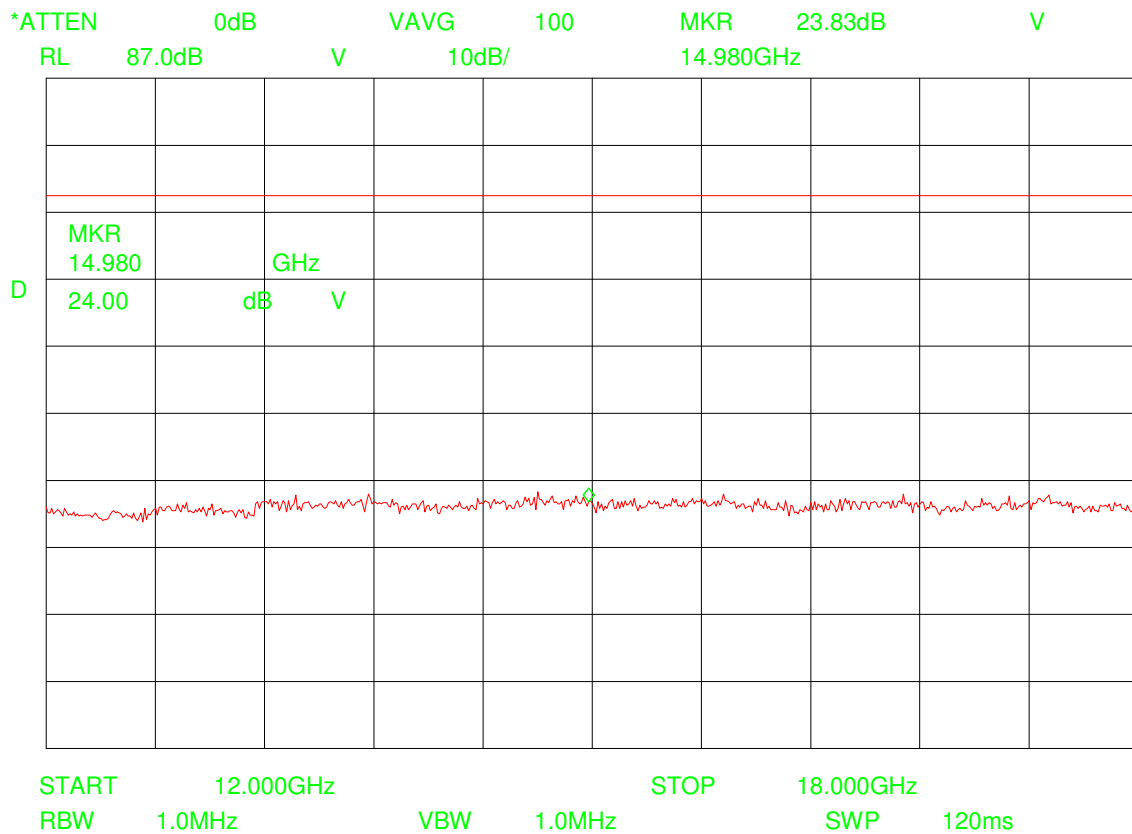
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Plot no.: 6

Radiated emissions 12 GHz to 18 GHz



Measurement distance $d = 0.5 \text{ m}$

Calculation :

Distance correction $3.0\text{m} \Rightarrow 0.5\text{m} = 15.5 \text{ dB}$

Limit at $3.0 \text{ m} = 54.0 \text{ dB}\mu\text{V/m}$

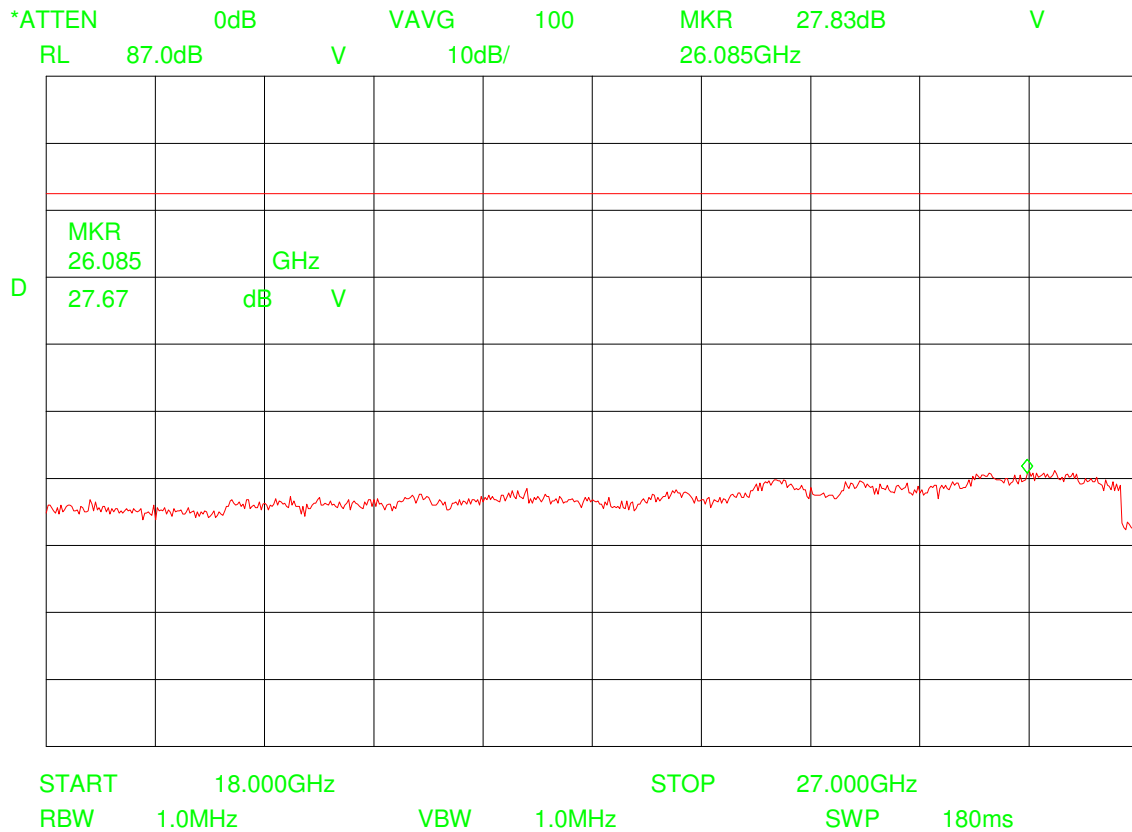
Limit at $0.5\text{m} = 54.0 \text{ dB}\mu\text{V/m} + 15.5 \text{ dB} = 69.5 \text{ dB}\mu\text{V/m}$

Field strength $= 24.0 \text{ dB}\mu\text{V/m}$ at 0.5m

Verdict : pass

Plot no.: 7

Radiated emissions 18 GHz to 27 GHz



Measurement distance $d = 0.5 \text{ m}$

Calculation :

Distance correction $3.0\text{m} \Rightarrow 0.5\text{m} = 15.5 \text{ dB}$

Limit at $3.0 \text{ m} = 54.0 \text{ dB}\mu\text{V/m}$

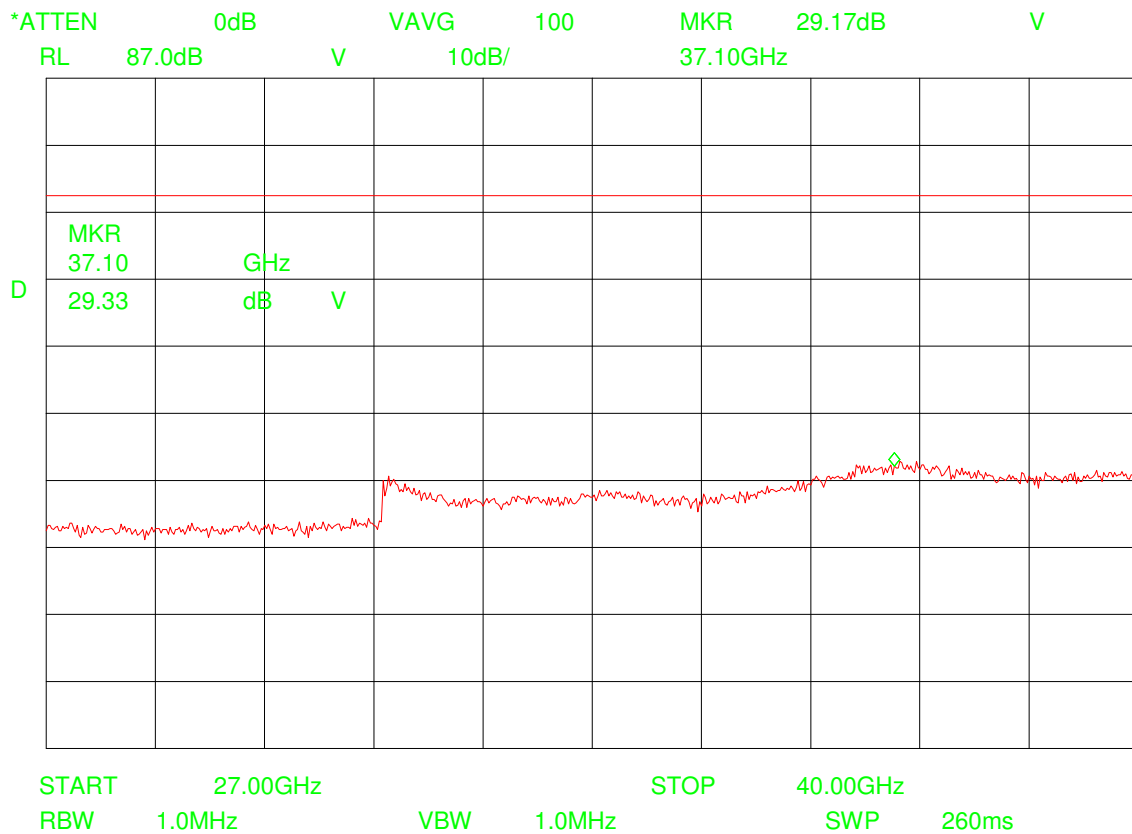
Limit at $0.5\text{m} = 54.0 \text{ dB}\mu\text{V/m} + 15.5 \text{ dB} = 69.5 \text{ dB}\mu\text{V/m}$

Field strength $= 27.6 \text{ dB}\mu\text{V/m}$ at 0.5m

| | |
|-----------|------|
| Verdict : | pass |
|-----------|------|

Plot no.: 8

Radiated emissions 27 GHz to 40 GHz



Measurement distance d = 0.5 m

Calculation :

Distance correction 3.0m => 0.5m = 15.5 dB

Limit at 3.0 m = 54.0 dB μ V/m

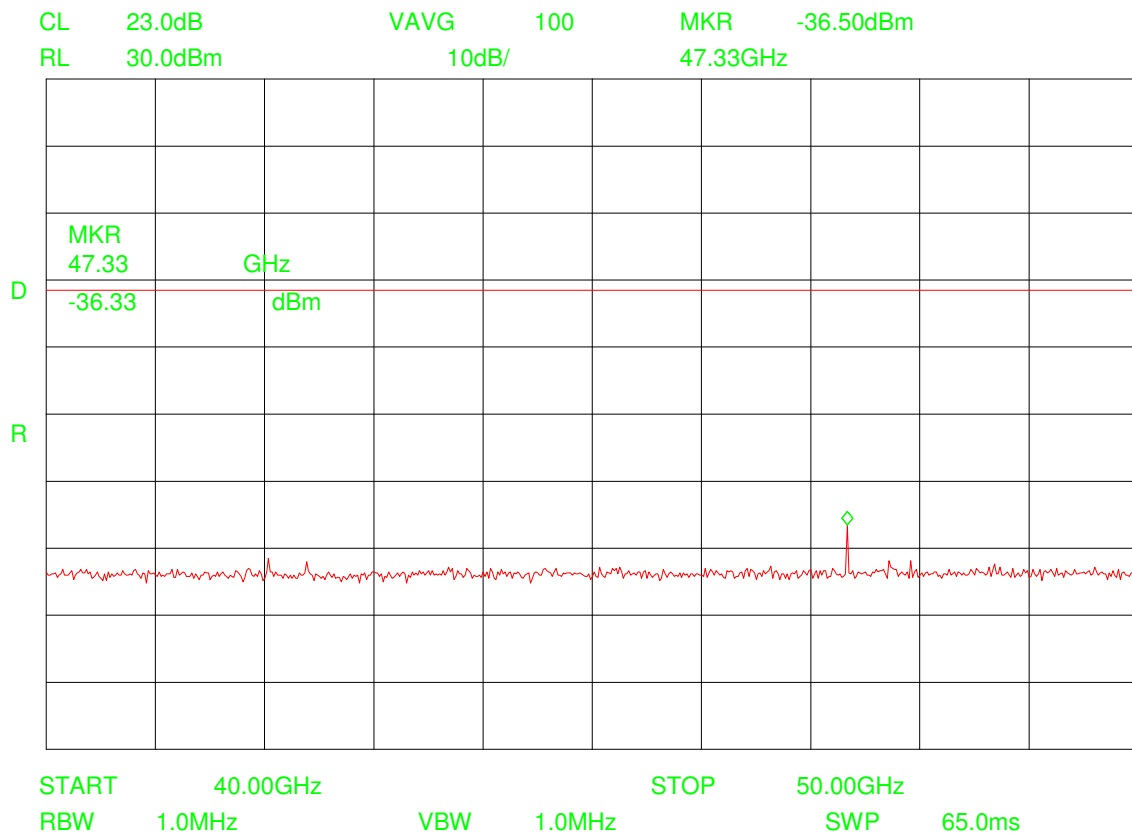
Limit at 0.5m = 54.0 dB μ V/m + 15.5 dB = 69.5 dB μ V/m

Field strength = 29.3 dB μ V/m at 0.5m

| | |
|-----------|------|
| Verdict : | pass |
|-----------|------|

Plot no.: 9

Radiated emissions 40 GHz to 50 GHz



Measurement distance d = 0.5 m

The correction is calculated by the measuring system.

Calculation :

Power density = EIRP (mW) / $4 \cdot \pi \cdot 300\text{cm} \cdot 300\text{cm}$

Maximum spurious = $0.23 \mu\text{W} (-36.3 \text{ dBm})$ / 1130973.4
 = 0.21 pW/cm^2

Limit at 3m = 600 pW/cm^2

| | |
|-----------|------|
| Verdict : | pass |
|-----------|------|

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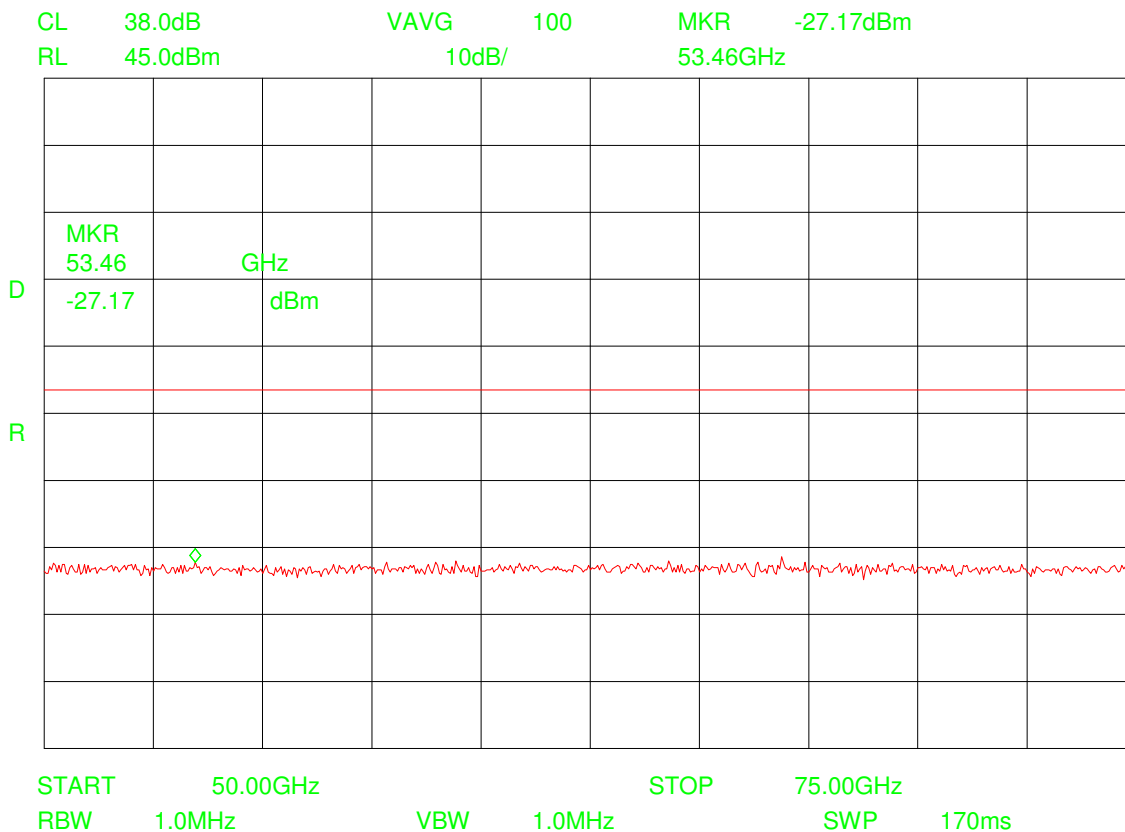
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Plot no.: 10

Radiated emissions 50 GHz to 75 GHz



Measurement distance d = 0.5 m

The correction is calculated by the measuring system.

Calculation :

Power density = EIRP (mW) / $4 \cdot \pi \cdot 300\text{cm} \cdot 300\text{cm}$

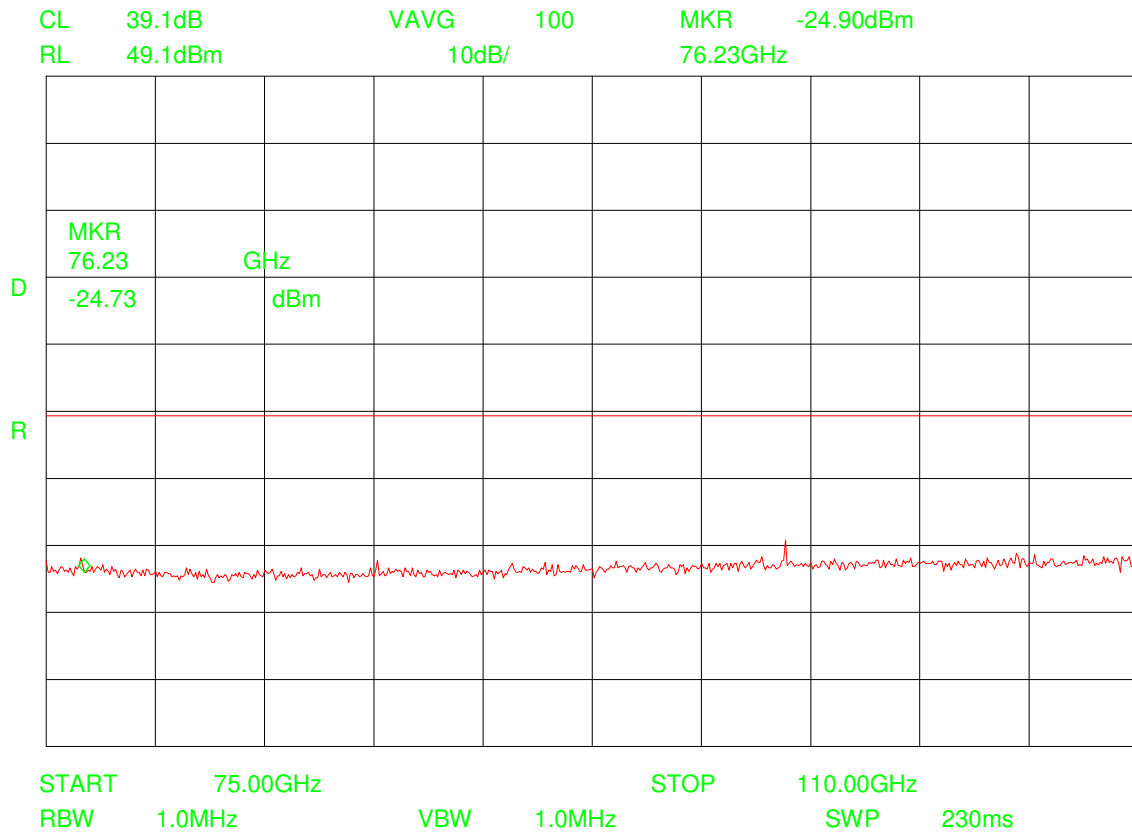
Maximum spurious = 1.95 μW (-27.1 dBm) / 1130973.4
 = 1.72 pW/ cm^2

Limit at 3m = 600pW/ cm^2

| | |
|-----------|------|
| Verdict : | pass |
|-----------|------|

Plot no.: 11

Radiated emissions 75 GHz to 110 GHz



Measurement distance d = 0.5 m

The correction is calculated by the measuring system.

Calculation :

Power density = EIRP (mW) / $4 \cdot \pi \cdot 300\text{cm} \cdot 300\text{cm}$

Maximum spurious = 3.39 μW (-24.7 dBm) / 1130973.4
= 3.0 pW/cm²

Limit at 3m = 600 pW/cm²

| | |
|-----------|------|
| Verdict : | pass |
|-----------|------|

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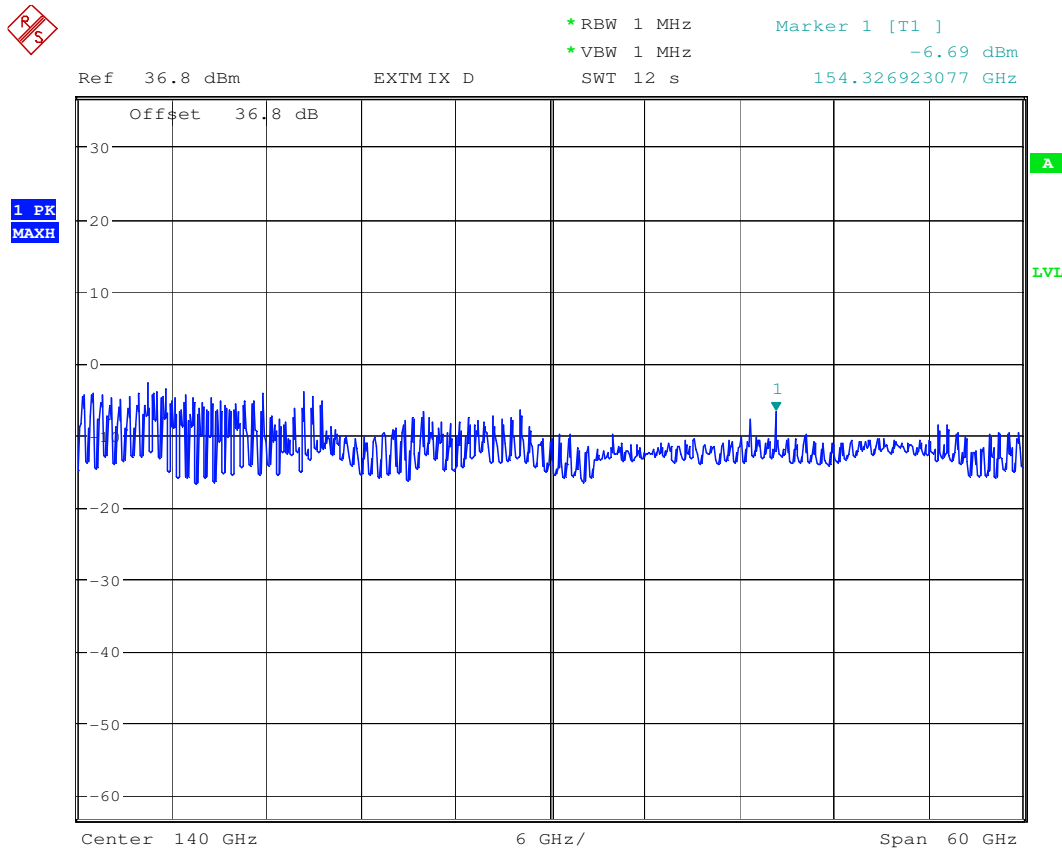
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Plot no.: 12

Radiated emissions 110 GHz to 170 GHz



Date: 10.OCT.2007 13:38:32

Measurement distance d = 0.5 m

The correction is calculated by the measuring system.

Calculation :

Power density = EIRP (mW) / $4 \cdot \pi \cdot 300\text{cm} \cdot 300\text{cm}$

Maximum spurious = 214 μW (-6.7 dBm) / 1130973.4

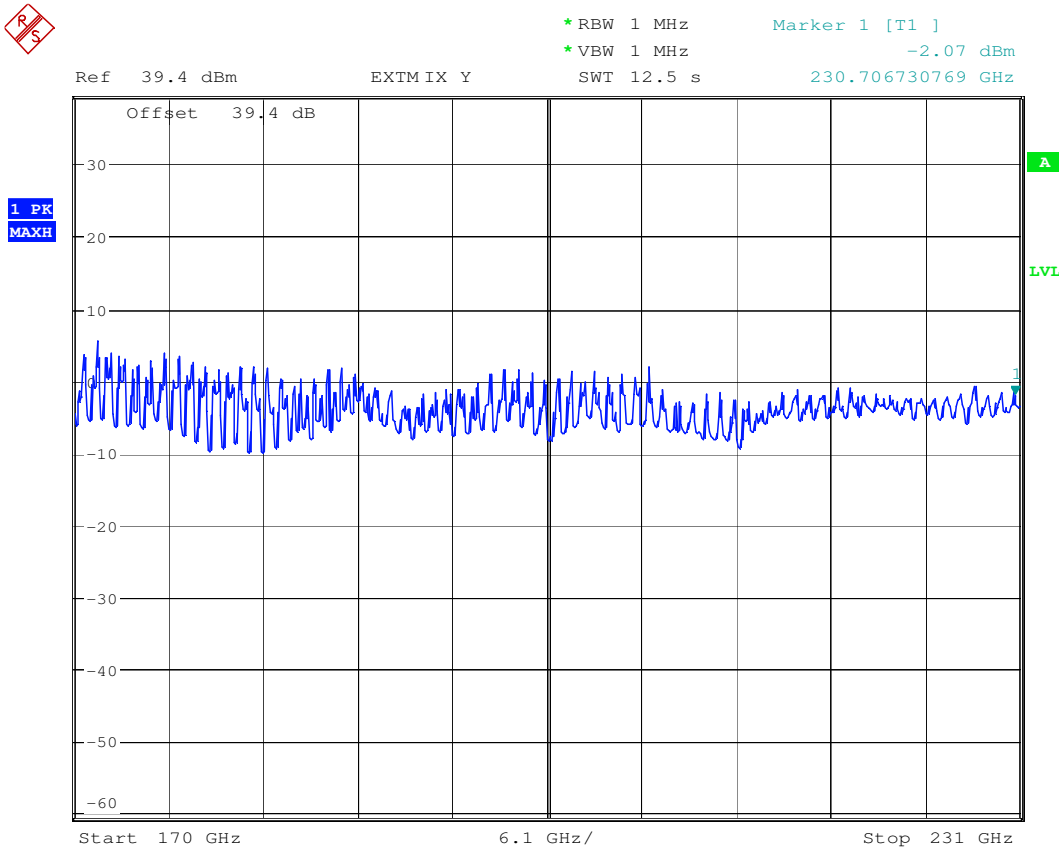
= 189 pW/cm²

Limit at 3m = 600pW/cm²

Verdict : pass

Plot no.: 13

Radiated emissions 170 GHz to 231 GHz



Date: 10.OCT.2007 14:17:49

Measurement distance d = 0.5 m

The correction is calculated by the measuring system.

Calculation :

Power density = EIRP (mW) / $4 \cdot \pi \cdot 300\text{cm} \cdot 300\text{cm}$

Maximum spurious = 0.6171 mW (-2.1 dBm) / 1130973.4
 = 545.6 pW/cm²

Limit at 3m up to 200 GHz = 600pW/cm²

Limit at 3m above 200 GHz = 1000pW/cm²

| |
|---------------------|
| Verdict : pass |
|---------------------|

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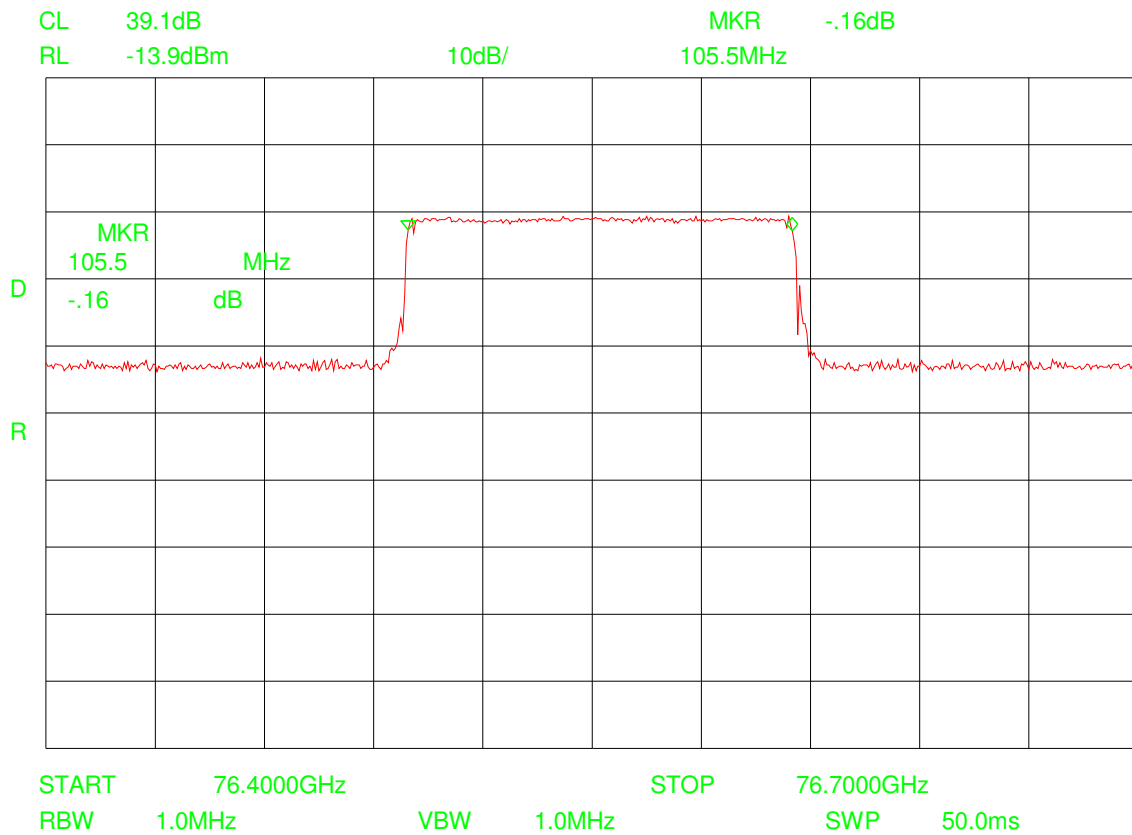
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Occupied frequency range:

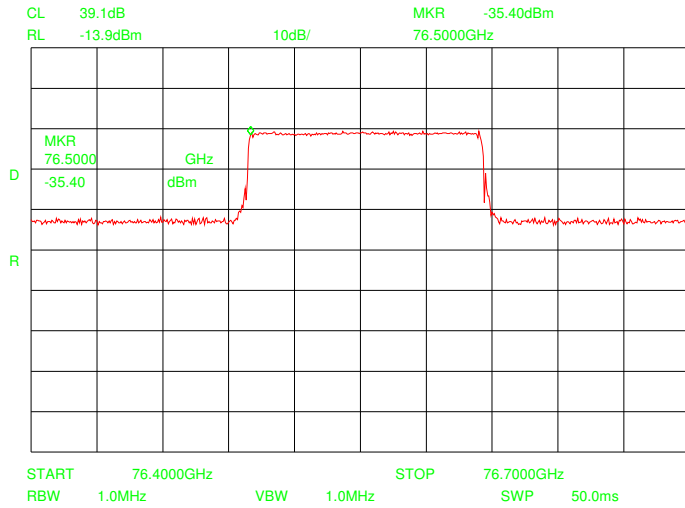
Plot no.: 14



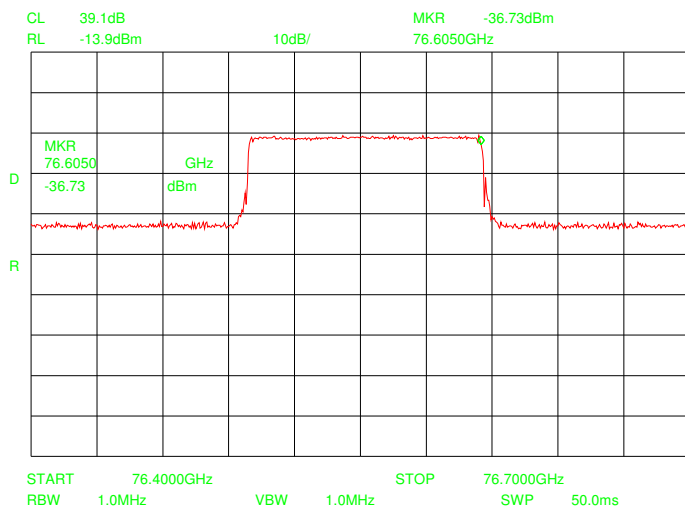
Occupied frequency range: 105.5 MHz

Verdict : pass

Plot no.: 15 and 16



The occupied frequency is between 76.500 GHz and 76.605 GHz



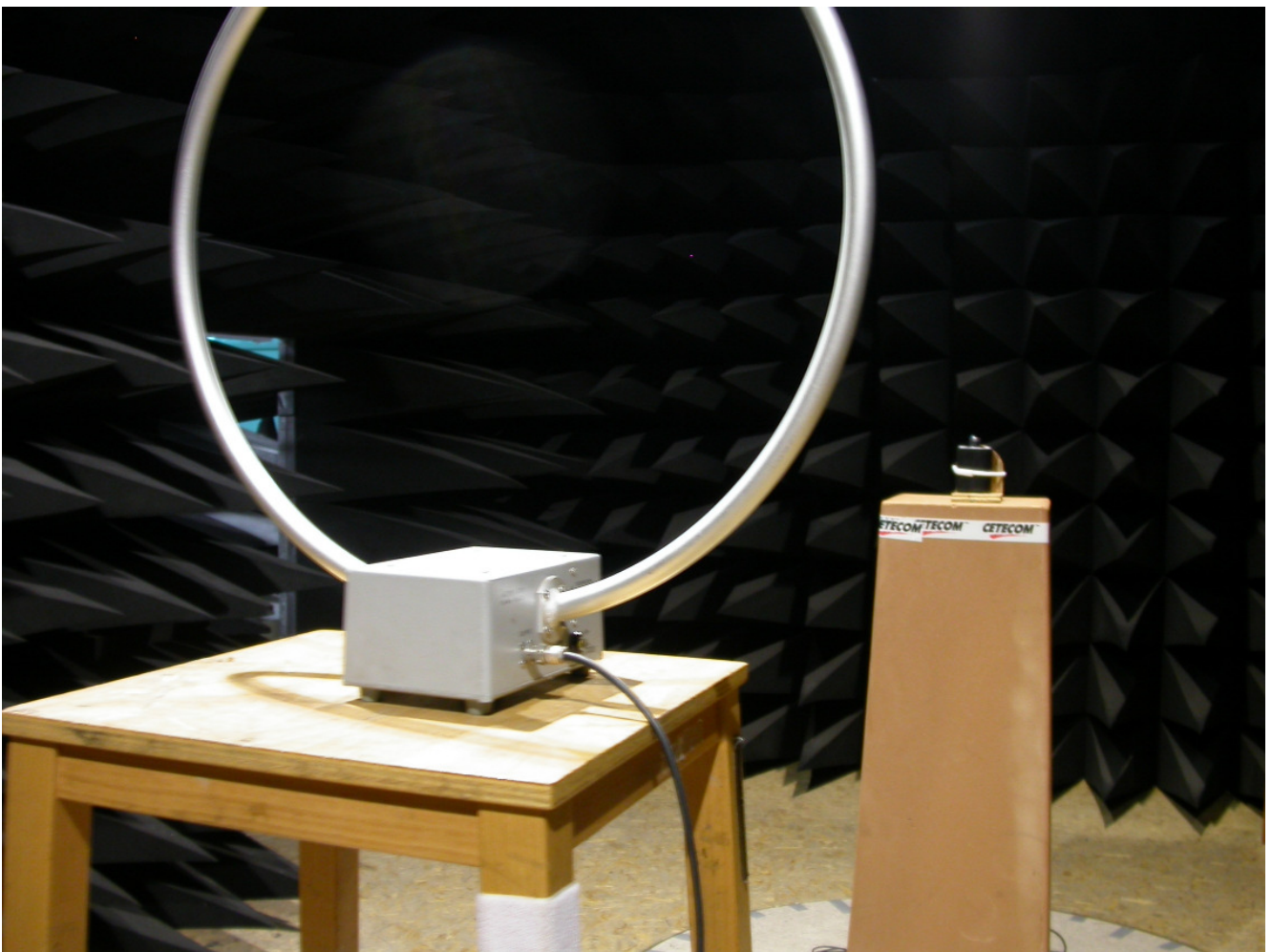
The center frequency is calculated 76.552 500 GHz.

Verdict : pass

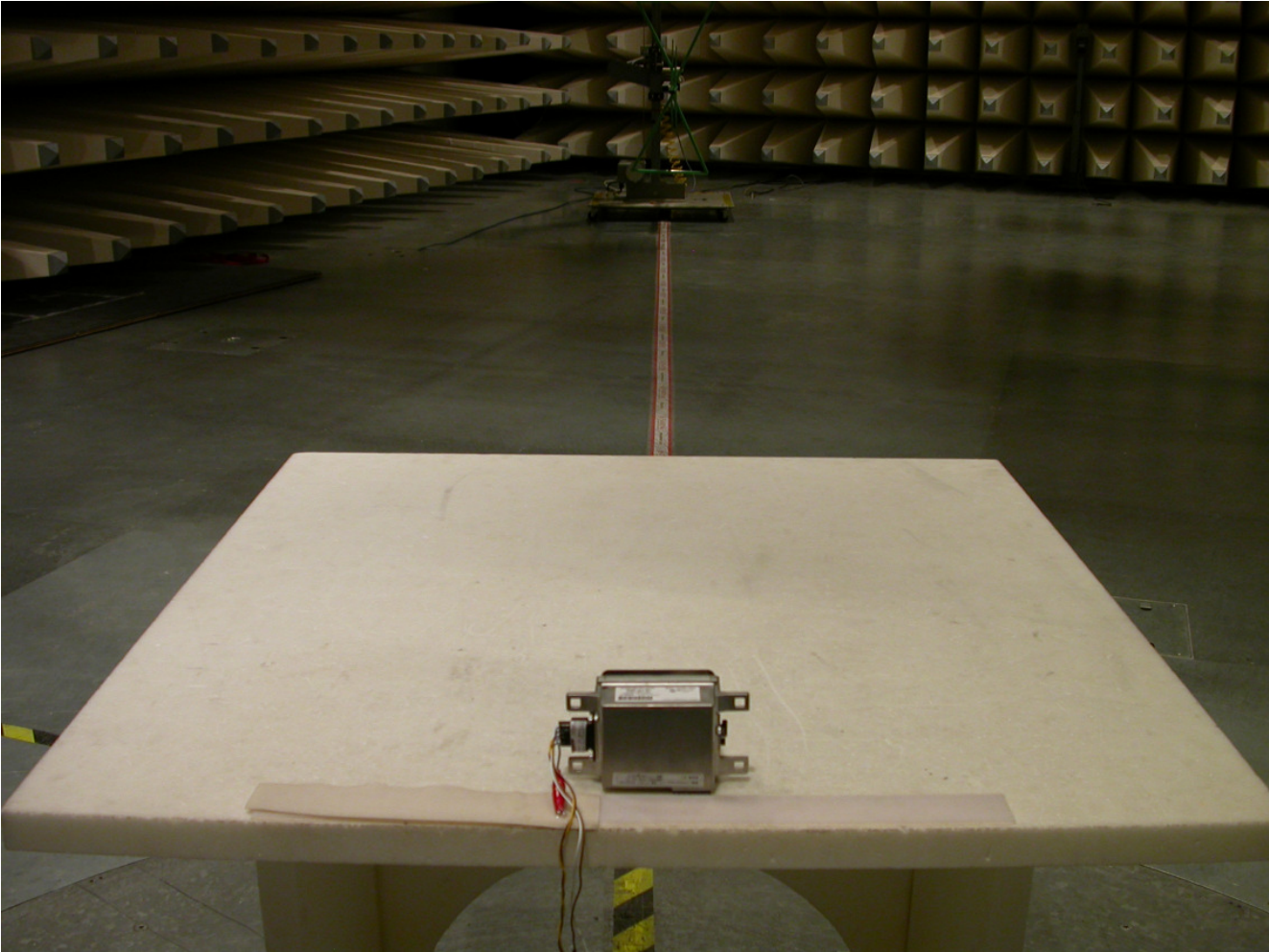
4 Photographs

4.1 Photographs of the test set-up

Radiated Emission



Radiated Emission



Test set-up



4.2 Photographs of the EUT



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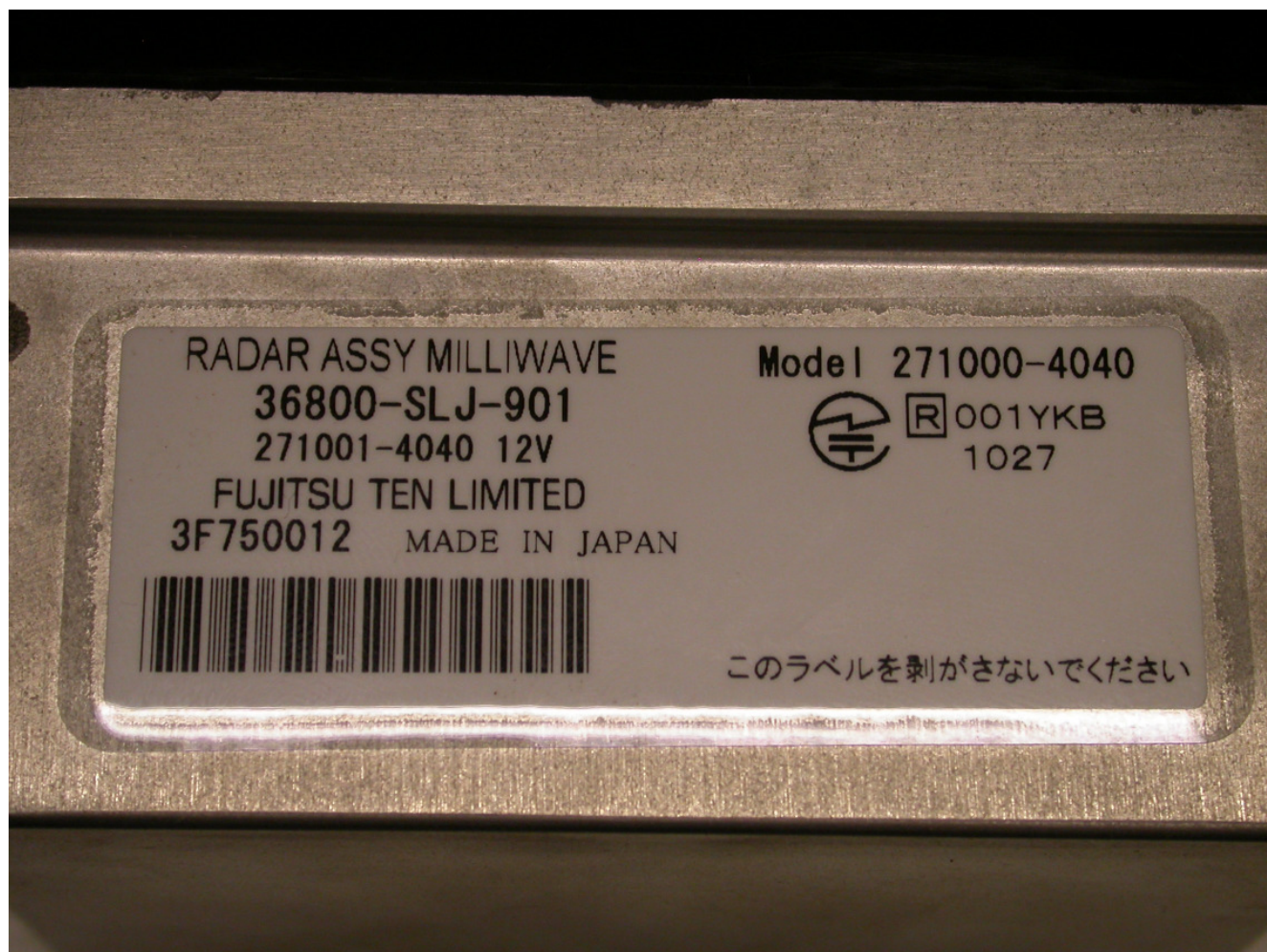


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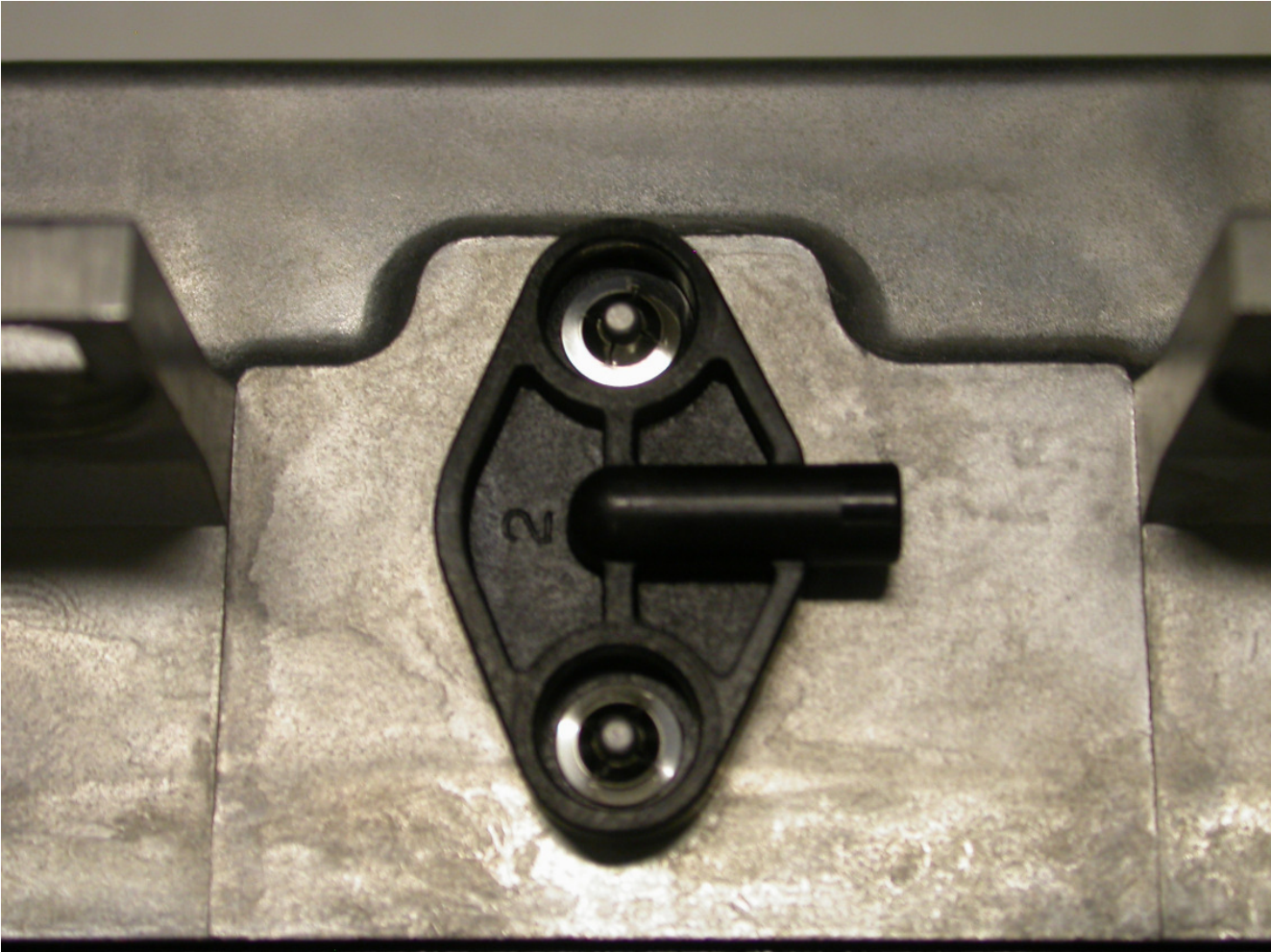
Date : 2007-10-12

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