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

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

Independent ETSI
compliance test house

Test report No.: 2-4418-01-03/06
Applicant : DENSO CORPORATION
Type : DNMWR003
Test standards : FCC Part 15 (06/2005) / RSS210 Issue 6
FCC ID : HYQDNMWR003
IC ID : 1551A-DNMWR003

Table of contents

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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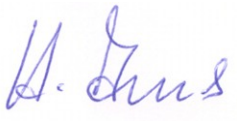
Tester:

Date	Name	Signature
2006-08-11	Manfred Paschwitz	

Technical responsibility for area of testing:

Date	Name	Signature
2006-08-11	Harro Ames	

1.2 Testing laboratory

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

CETECOM ICT Services GmbH
P.O. Box 65 01 55
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e-mail : info@ict.cetecom.de
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 : DENSO CORPORATION
Street : 1-1, Showa-cho, Kariya-shi
Town : Aichi-ken, 448-8661
Country : Japan
Telephone : +81(0)566-25-5947
Fax : +81(0)566-25-4548

Contact person
Name : Mr. Kazuo Sakakibara
Telephone : +81(0) 566 25 5947
Fax : +81(0) 566 25 4548
e-mail : KAZUO_SAKAKIBARA@denso.co.jp

1.4 Application details

Date of receipt of application : 2006-08-03
Date of receipt of test item : 2006-08-07
Date of test : 2006-08-07 and 2006-08-10

1.5 Test item (EUT)

Description of EUT	:	76 GHz millimeter-wave radar sensor
System designation	:	Automatic cruise control system
Type designation	:	DNMWR003
Manufacturer	:	Denso Corporation
Street	:	1-1, Showa-cho, Kariya-shi
Town	:	Aichi-ken, 448-8661
	:	Japan

1.6 Technical data

Frequency range	:	76.000 GHz ... 77.000 GHz
Operational frequency	:	76.425 GHz
EIRP PEP	:	1.12 W Peak (30.5 dBm Peak)
	:	0.132 W AV (21.2 dBm AV)
Type of modulation	:	401MF0N
Pulse spacing	:	100.0 ms
Pulse width	:	11.7 ms (see timing diagram, page 15)
Microwave modules	:	TX / RX – Module-integrated fixed antennas
Normal DC power supply	:	12.0 V
Extreme DC power supply	:	10.8 V ... 15.6 V

1.6.1 Operation conditions

Operation	:	As soon as the equipment is powered up, TX and RX start operating. The system is remote controlled by a control unit. If the velocity of car is 0 km/h, the RF-part is deactivated, no RF is radiated.
Purpose of operation	:	Automatic distance measurement and cruise control for vehicle application

1.6.2 Equipment under test

Model	S/N	I/F-Box	PC as controller
DNMWR003	001	serial-bus	

1.6.3 Test Report Cover Sheet / Performance Test Data

Equipment Model Number:	DNMWR003
Certification Number:	1551A-DNMWR003
Manufacturer:	Denso Corporation 1-1, Showa-cho, Kariya-shi Aichi-ken, 448-8661 Japan
Tested to Radio Standards Specification (RSS) No.:	RSS210 Issue 6
Open Area Test Site Industry Canada Number:	3463
Frequency Range (or fixed frequency):	76.000 – 77.000 GHz
Power Density:	0.992 µW/cm²(Peak) @ 3m
Occupied Bandwidth (99% BW):	401.0 MHz
Type of Modulation:	FM CW
Emission Designator (TRC-43):	401MF0N
Transmitter Spurious (worst case):	< 500µV/m @ 3m
Receiver Spurious (worst case):	Not applicable
Antenna Type:	Fixed 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: 2006-08-11

Test engineer: Harro Ames

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 License-Exempt Radio communication Devices for Cat I equipment Annex 13 Vehicle -Mounted Field Disturbance Sensors RSS210 Issue 6

2 Technical test

2.1 Summary of test results

[X] 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:

[X] 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.

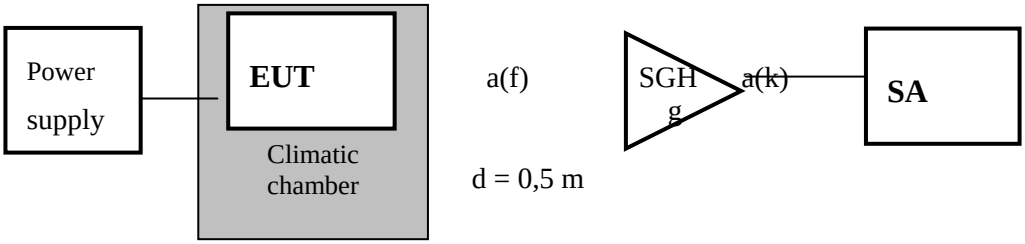
2.3 Measurement and test set-up

The measurement and test set-up is defined in the technical specification .

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 26 GHz

Spurious radiation (EIRP; PEP)



Frequency f (GHz)	Measurement distance (m)	a(sys) [dB]	a(f) [dB]	a(k) [dB]	g [dBi]
12.0 ... 18.0	0.5	34.8	51.6	1.7	18.4
18.0 ... 26.0	0.5	38.2	54.4	2.2	18.4

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

a(sys) = a(f) + a(k) - g

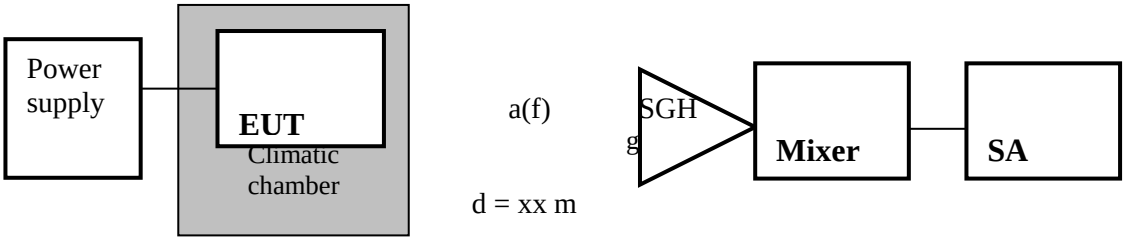
Test equipment	Manufacturer	Type	S/No. – Cetecom No.
Spectrum Analyser	HP	HP 8565E	3738A00773
SGH 12.4.. 18.0 GHz	narda	638	01005
SGH 18 ... 27 GHz	narda	638	01005
Power supply	HP	HP 6032A	2848A07227
Climatic chamber	Vötsch	VUK 04/500	522/32678
RF-cable	HP	5061-5359	P36303

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 26 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]
26.0 ... 40.0	0.25	28.0	49.0	21.0
40.0 ... 60.0	0.25	27.0	52.5	25.5
60.0 ... 90.0	0.125	27.0	50.0	23.0
76.5	0.5	45.6	64.1	18.5
90.0 ... 140.0	0.125	29.0	53.6	24.6
140.0 … 170.0	0.125	31.0	57.4	26.4
170.0 … 231.0	0.125	34.5	57.1	23.0

Calculation of system attenuation = free space attenuation – antenna gain

a(sys) = a(f) - g

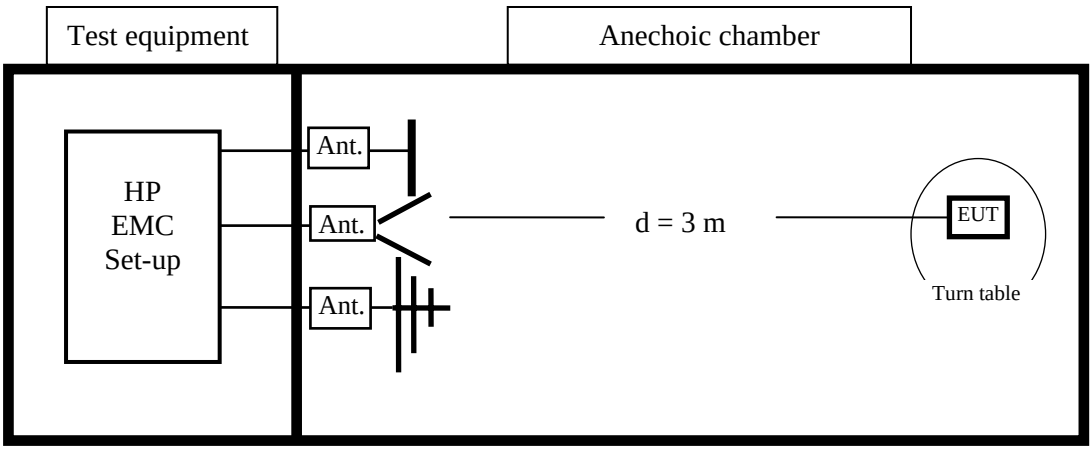
Test equipment	Manufacturer	Type	S/No. – Cetecom No.
Spectrum Analyser	HP	8565E	3738A00773
Spectrum Analyser	R&S	FSU	1166.1660.50
SGH 27 40 GHz	Flann	2224	300001976
Mixer 27 40 GHz	Tektronix	WM490A	300000493c
SGH 40 60 GHz	Flann	2424	300001200g
Mixer 40 60 GHz	Tektronix	WM490U	300000298b
SGH 50 75 GHz	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 170 231 GHz	Thomson	3024	300002001
Mixer 170 231 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 110 GHz to 325 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 325 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 are 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 "Millimeter 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. Tests are also performed with RBW 10.0 and Video bandwidth filter (VBW) 7.0 MHz. The received EIRP does not change when RBW and VBW are set to higher values.

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:

Power density	=	EIRP	/	Antenna aperture area	[mW/cm ^{2}]
pd	=	eirp	–	a	[dB(mW/cm ^{2})]

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 ºC 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 + 1ºC/minute. During warming-up time the frequency stability and the EIRP is monitored constantly. After 2 hours the temperature stability at 55 ºC 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 SGHs. 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 (λ = 0.0039 m), the far field starts at R > 0.205 m.

The peak power density is measured in 3 m distance as 0.992 µW/cm ^{2}.

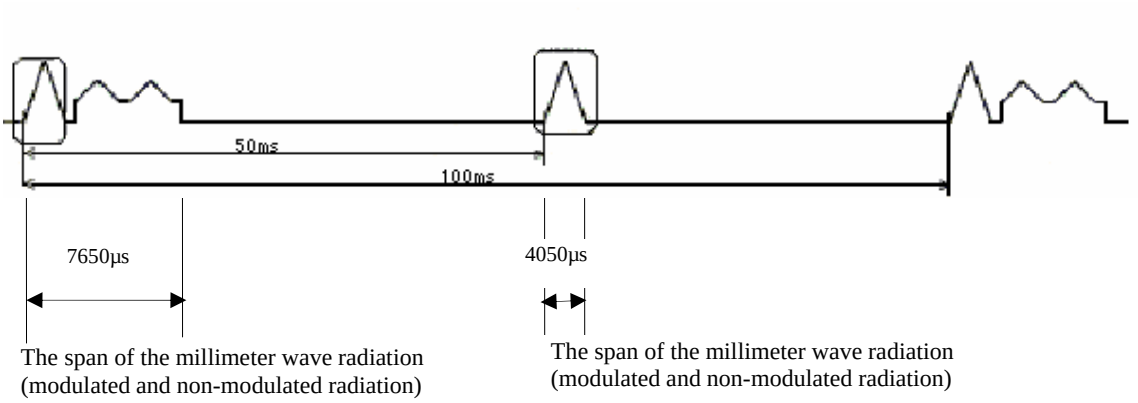
Peak Power (EIRP) $EIRP = PD * 4\pi * R^2$

$EIRP = 1.12$ W (30.5 dBm)

As the sample works with switched CWFM-modulation there is a difference between peak and average value of the output power.

DENSO

The Duty Cycle



Millimeter Radar Sensor (DNMWR003)

As the output is switched on/off with 11.7 % duty cycle, we have a correction factor of -9.3 dB.

So the average result is 21.2 dBm = 0.132 Watt

Limit of maximum ERP for frequencies above 1.5 GHz is 3 W. See FCC § 2.1091 (EIRP = 4.91 Watt)

RF Exposure for mobile conditions at **R = 20 cm** distance from EUT

$$PD = EIRP / (4\pi * R^2)$$
$$PD = 0.026 \text{ mW/cm}^2$$

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): MILIMETER-WAVE RADAR
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
Antenna assembly: Fixed antenna

TEST CONDITIONS T = 23.0 ° C	TRANSMITTER POWER DENSITY		
EUT operating: TX on and RX on	Frequency f [GHz]	Power Density PD [µW/cm ^{2}]	See plot on page
U DC = 10.0 V	76.418 500	0.992	
U DC = 11.0 V	76.418 500	0.992	
U DC = 12.0 V	76.418 500	0.992	25
U DC = 13.0 V	76.418 500	0.992	
U DC = 14.0 V	76.418 500	0.992	
U DC = 15.0 V	76.418 500	0.992	
U DC = 16.0 V	76.418 500	0.992	

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 [µW/cm ^{2}]
76.0 to 77.0	3.0	-12.2	60

Verdict:	Power Density limit is kept

Equipment under test (EUT): MILIMETER-WAVE RADAR
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
Antenna assembly: Fixed antenna

TEST CONDITIONS T = - 20.0 ° C	TRANSMITTER POWER DENSITY		
EUT operating: TX on and RX on	Frequency f [GHz]	Power Density PD [µW/cm ^{2}]	
U DC = 10.0 V	76.421 800	0.992	
U DC = 11.0 V	76.421 800	0.992	
U DC = 12.0 V	76.421 800	0.992	
U DC = 13.0 V	76.421 800	0.992	
U DC = 14.0 V	76.421 800	0.992	
U DC = 15.0 V	76.421 800	0.992	
U DC = 16.0 V	76.421 800	0.992	

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 [µW/cm ^{2}]
76.0 to 77.0	3.0	-12.2	60

Verdict:	Power Density limit is kept

Equipment under test (EUT): MILIMETER-WAVE RADAR
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
Antenna assembly: Fixed antenna

TEST CONDITIONS T = + 55.0 ° C	TRANSMITTER POWER DENSITY		
EUT operating: TX on and RX on	Frequency f [GHz]	Power Density PD [µW/cm ^{2}]	
U DC = 10.0 V	76 421 000	0.992	
U DC = 11.0 V	76 421 000	0.992	
U DC = 12.0 V	76 421 000	0.992	
U DC = 13.0 V	76 421 000	0.992	
U DC = 14.0 V	76 421 000	0.992	
U DC = 15.0 V	76 421 000	0.992	
U DC = 16.0 V	76 421 000	0.992	

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 [µW/cm ^{2}]
76.0 to 77.0	3.0	-12.2	60

Verdict:	Power Density limit is kept

Equipment under test (EUT): MILIMETER-WAVE RADAR
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 FREQUENCY
EUT operating:	Frequency f [GHz]
T = -20°	76.421 800
T = -10°	76.425 900
T = 0°	76 427.600
T = +10°	76 432 700
T = +20°	76.418 500
T = +30°	76 409 550
T = +40°	76 405 500
T = +50°	76 415 250
T = +55°	76 421 000

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

Verdict:	Frequency tolerance limits are kept

Equipment under test (EUT): MILIMETER-WAVE RADAR
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
Antenna assembly: Fixed antenna

TEST CONDITIONS	TRANSMITTER SPURIOUS FIELD STRENGTH			
Frequency range [MHz]	Spurious frequencies [MHz]	S A e [dBµV/m]	E [µV/m]	See plot on page
0.009 – 30.000 (h + v) horizontal and vertical plane	Noise	< limit	< limit	26
30.0 MHz – 4.0 GHz (h + v)	Noise	< limit	< limit	27
4.0 GHz – 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 [dBµV/m] @ 3 m	Field strength E [µV/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 – 12.0 GHz	3	54.0	500

Verdict: Field strength limits are kept

Equipment under test (EUT): MILIMETER-WAVE RADAR
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
Antenna assembly: Fixed antenna

TEST CONDITIONS		TRANSMITTER SPURIOUS FIELD STRENGTH			
Frequency range [GHz]		Spurious frequencies [GHz]	S A e [dBµV/m]	E [µV/m]	See plot on page
12.0 – 18.0	(h + v)	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 [dBµV/m] @ 3 m	Field strength E [µV/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

Equipment under test (EUT): MILIMETER-WAVE RADAR
Ambient temperature: 23 °C
Relative humidity: 35 %

TRANSMITTER PARAMETERS SECTION 15.253

SPURIOUS EMISSIONS SECTION 15.253 c (2) + (3)
In the frequency range 40.0 GHz to 231.0 GHz

Operation: Vehicle in motion
Antenna assembly: Fixed antenna

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 – 60.0 (h + v)	Noise	< limit	< limit	32
60.0 – 76.0 (h + v)	Noise	< limit	< limit	33
76.0 – 77.0 (h + v)	TX			38
77.0 – 90.0 (h + v)	Noise	< limit	< limit	34
90.0 – 140.0 (h + v)	Noise	< limit	< limit	35
110.0 – 170.0 (h + v)	Noise	< limit	< limit	36
170.0 – 231.0 (h + v)	Noise	< limit	< limit	37

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 – 200.0 GHz	3.0	-62.2	600
200.0 GHz – 231.0 GHz	3.0	-60.0	1000

Verdict:	Power density limits are kept

Equipment under test (EUT): MILIMETER-WAVE RADAR
Ambient temperature: 23 °C
Relative humidity: 35 %

2.5.4 Not-In-motion Mode SECTION 15.253 (b) (1)

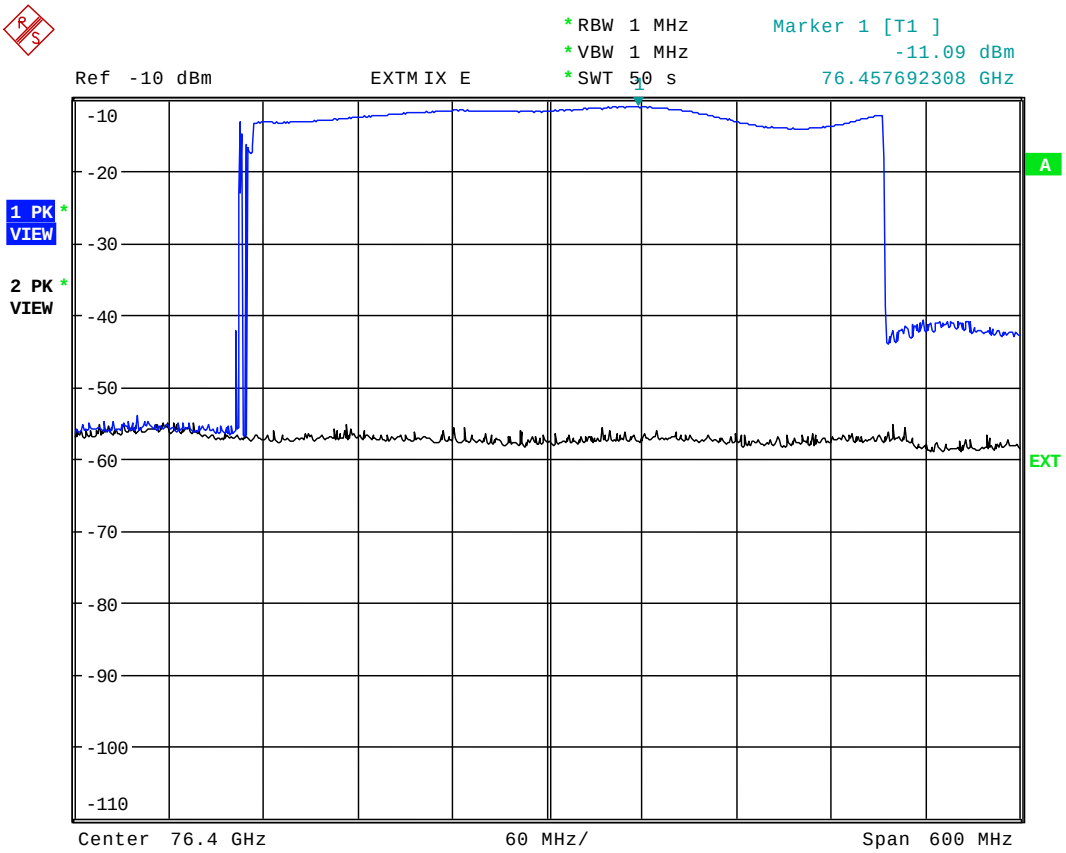
To show compliance with the requirements of Part 15.253 (b) (1) – Not-In-Motion mode, we tested with a serial -bus interface on a laptop with special software to simulate moving or not-moving of the car.

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.

First we set the normal mode, set the analyzer on ch.1 max hold (blue curve) and switched to the second channel.(black curve).
Here we switched the simulation to TX/RX Off mode (not in motion simulation).

The difference is > 45 dB. So the product fulfils the requirements.

Transmitted Power / Antenna Vertical (relative measurement, not optimized for maximum power)



The measured difference between in-motion and not-in-motion is ~ 45 dB.

Power of *in-motion* is approximately -30 dBm/cm^2 in 3 m measurement distance.
Power of *not-in motion* is maximum -75 dBm/cm^2 in 3 m measurement distance (noise floor).
So the sample fulfils the requirements.

Summary:

Frequency range [GHz]	Measurement distance [m]	In-motion [dBm/cm^2]	Not-in-motion [dBm/cm^2]	Delta [dB]
76.0 – 77.0	3.0	-30.0	-75.0	45.0

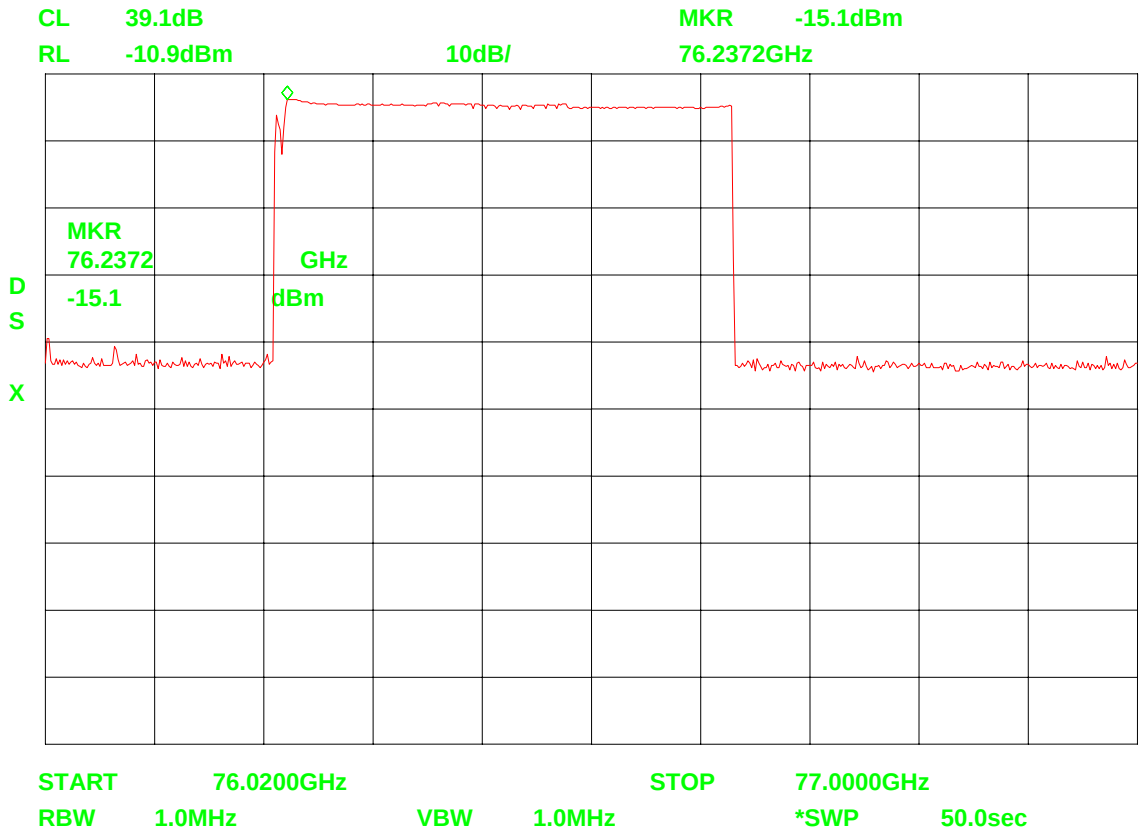
LIMITS: SECTION 15.253 (B) (1)

Frequency range [GHz]	Measurement distance [m]	In-motion	Not-in-motion	Delta [dB]
76.0 – 77.0	3.0	-12.2 dBm/cm^2	-37.0 dBm/cm^2	24.8
		60 µW/cm^2	200 nW/cm^2	

Verdict:	pass

3 Plots, graphs and data sheets

Plot 1

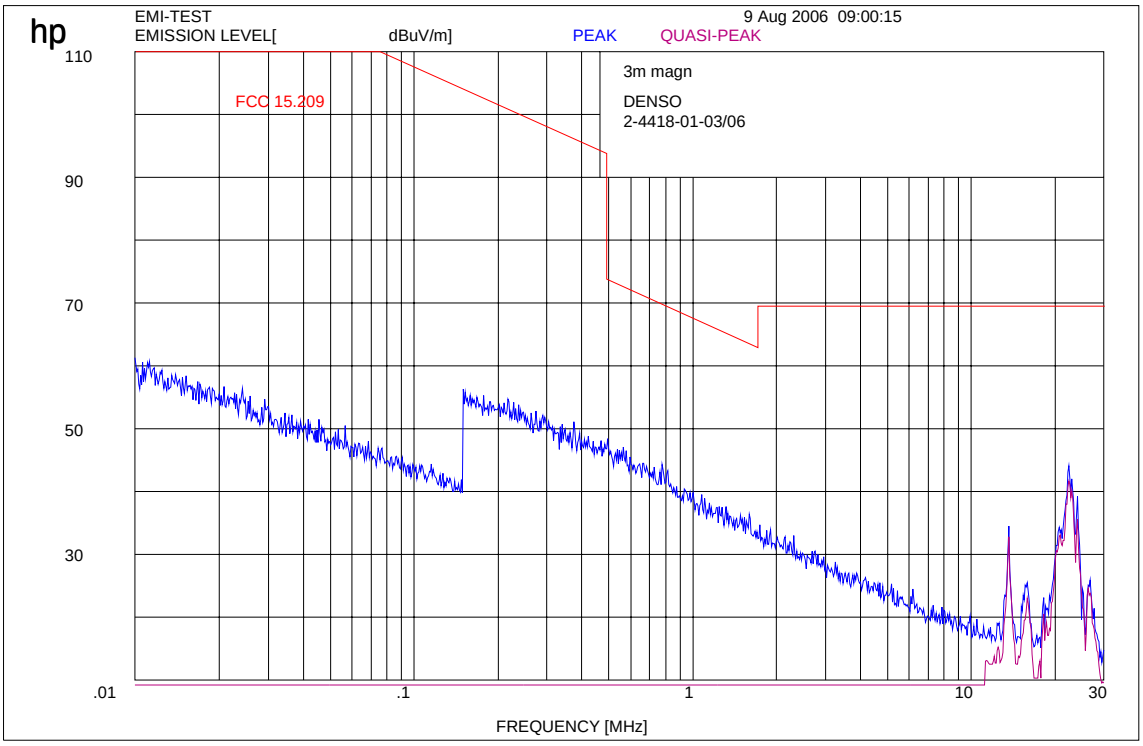


Measurement distance	d	= 0.5 m
Calculation: Power density		= EIRP (mW) / 4*Pi*300cm*300cm
Calculation of system attenuation		= free space attenuation – antenna gain
a(sys)		= 64.1 dB - 18.5 dB
		= 45.6 dB
Output power		= -15.1 dBm + 45.6 dB = 30.5 dBm = 1122 mW (Peak)
		= 1122 mW (30.5 dBm) / 1130973.4 cm^2
Power density		= 0.992 µW/cm^2 at 3.0 m
Limit		= 60µW/ cm^2 at 3.0 m

Verdict:	pass

Plot 2

Radiated emissions 9 kHz to 30 MHz

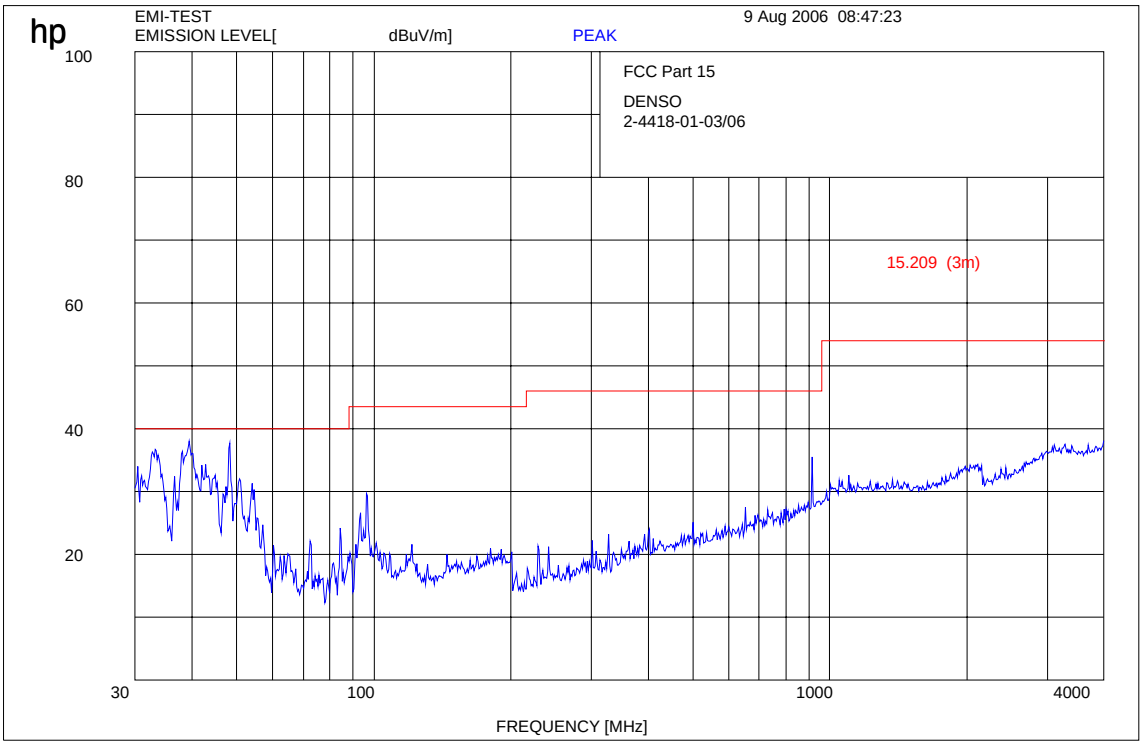


RBW/VBW: 200 Hz up to 150 kHz,
9 kHz up to 30 MHz,
120 kHz up to 1 GHz

Verdict:	pass

Plot 3

Radiated emissions 30 MHz to 4 GHz

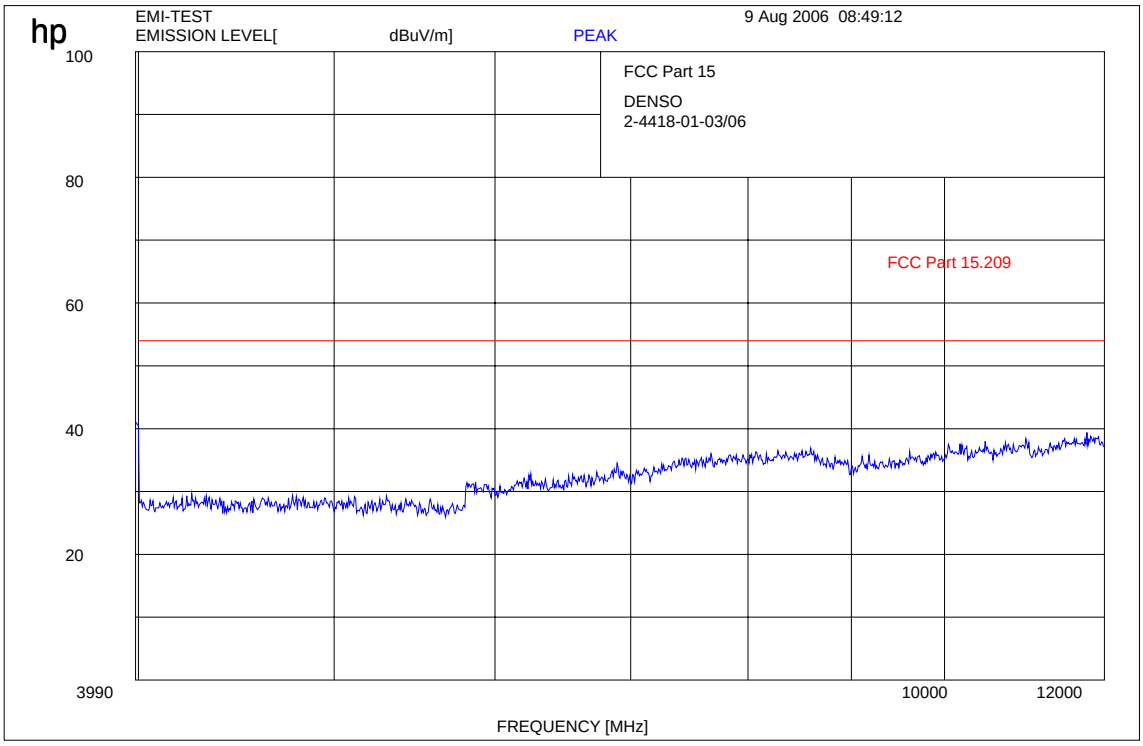


RBW/VBW: 200 Hz up to 150 kHz,
9 kHz up to 30 MHz,
120 kHz up to 1 GHz,
1 MHz above 1 GHz

Verdict:	pass

Plot 4

Radiated emissions 4 GHz to 12 GHz

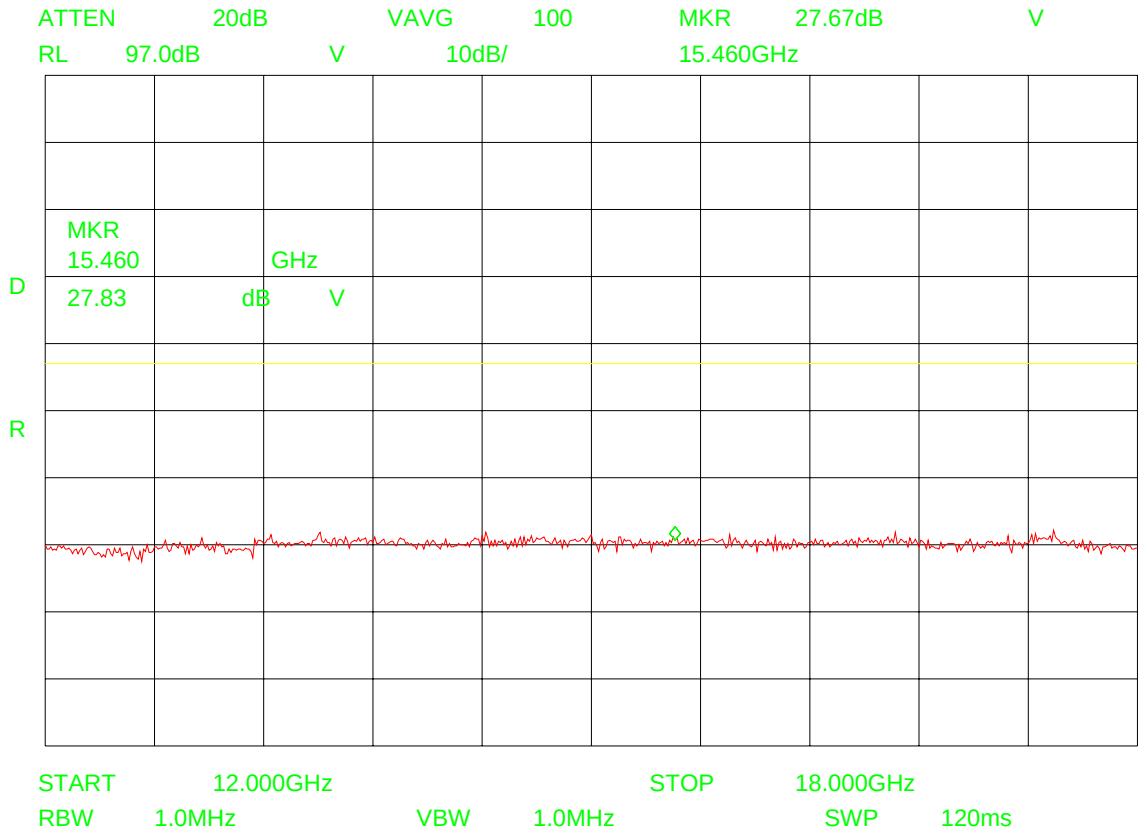


RBW/VBW: 200 Hz up to 150 kHz,
9 kHz up to 30 MHz,
120 kHz up to 1 GHz,
1 MHz above 1 GHz

Verdict:	pass

Plot 5

Radiated emissions 12 GHz to 18 GHz



Measurement distance d = 0.5 m

Calculation of system attenuation = free space attenuation + cable loss - antenna gain – dist. correction

a(sys) = a(f) + a(k) - g - dc

= 19.3 dB

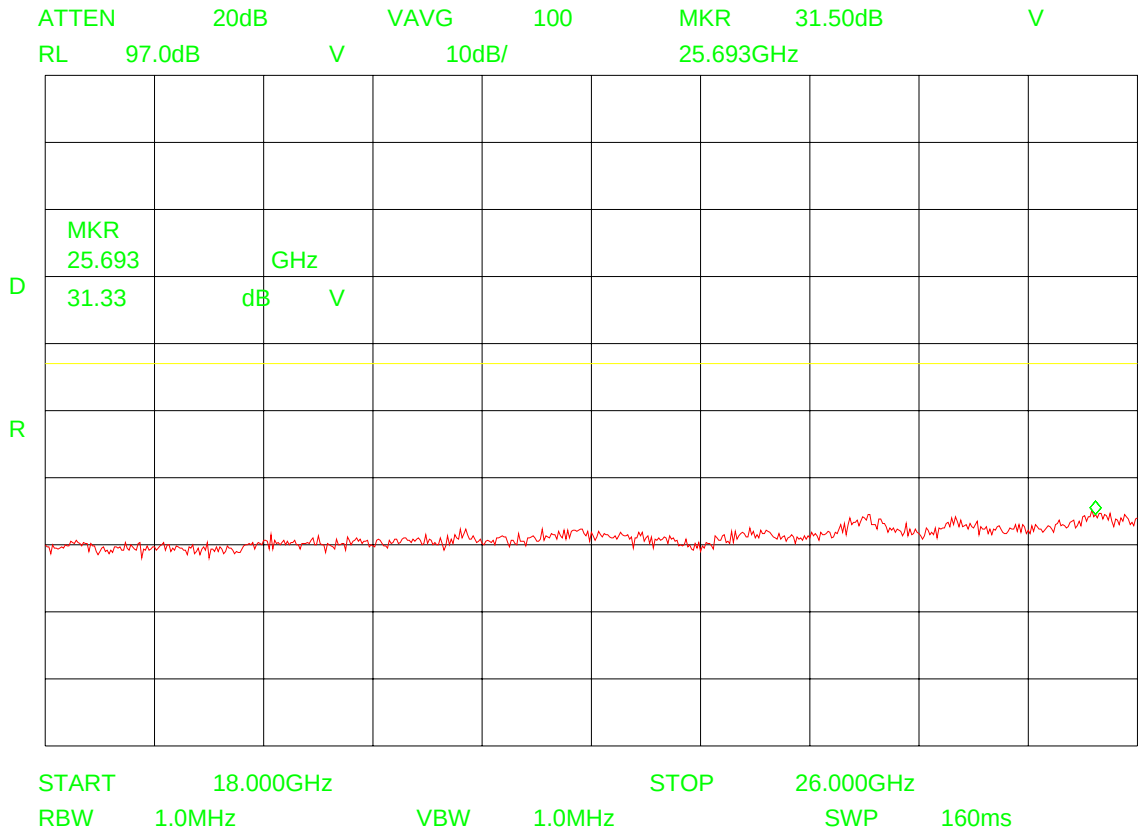
The system attenuation is calculated in the analyser reading.

Field strength = 27.8 dBµV/m at 3.0 m

Verdict:	pass

Plot 6

Radiated emissions 18 GHz to 26 GHz



Measurement distance d = 0.5 m

Calculation of system attenuation = free space attenuation + cable loss - antenna gain – dist. correction

a(sys) = a(f) + a(k) - g - dc

= 22.7 dB

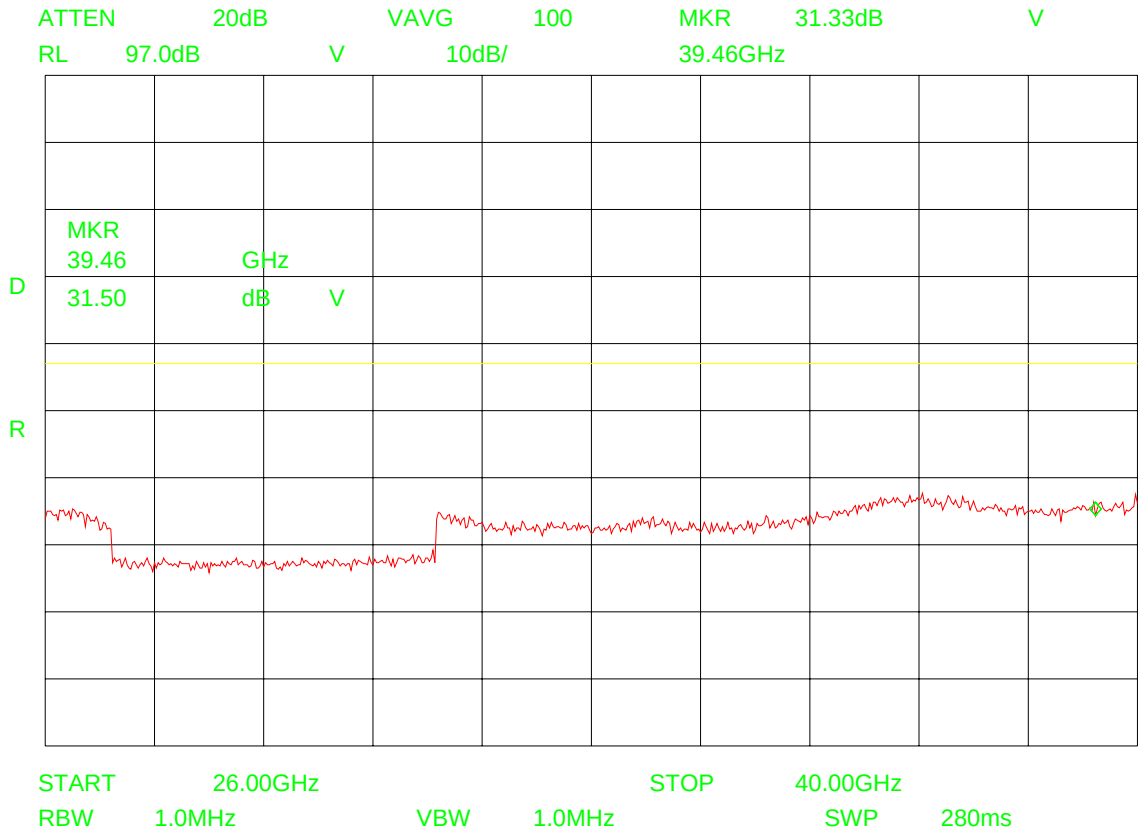
The system attenuation is calculated in the analyser reading.

Field strength = 31.3 dBµV/m at 3.0 m

Verdict:	pass

Plot 7

Radiated emissions 26 GHz to 40 GHz



Measurement distance d = 0.25 m

Calculation of system attenuation = free space attenuation + cable loss - antenna gain – dist. correction

a(sys) = a(f) + a(k) - g - dc

= 14.5 dB

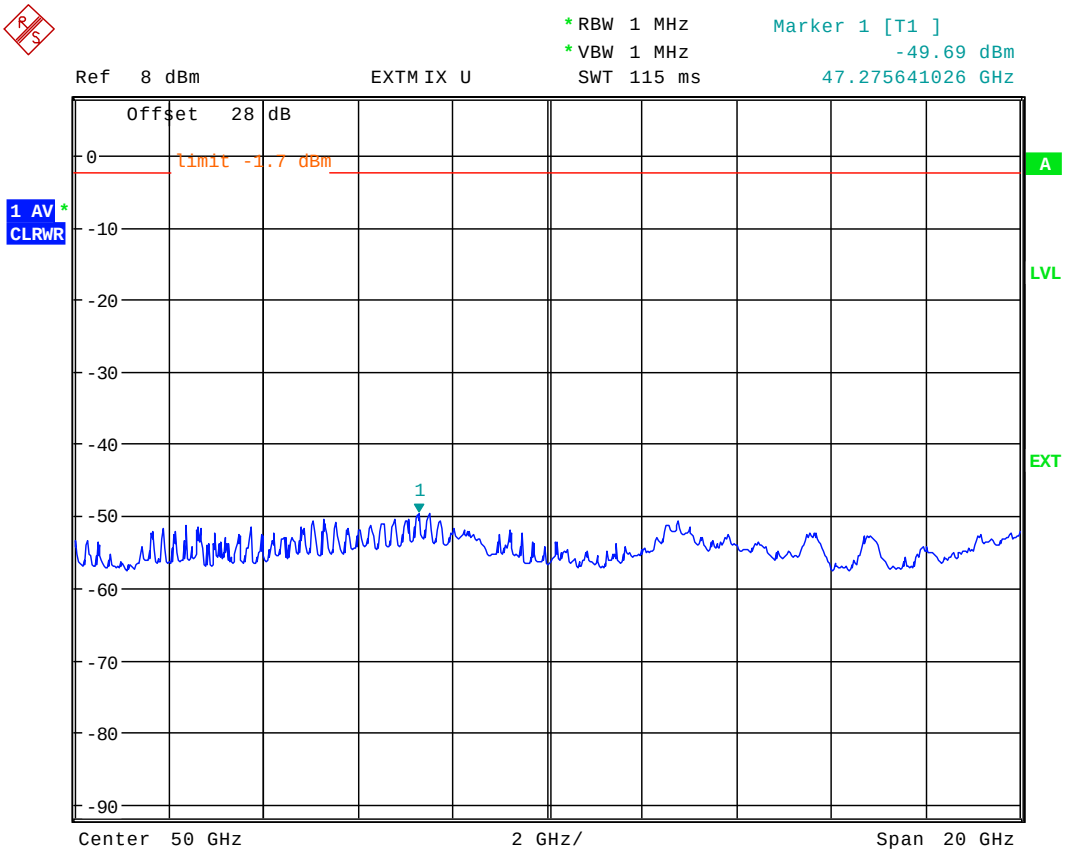
The system attenuation is calculated in the analyser reading.

Field strength = 31.5 dBµV/m at 3.0 m

Verdict:	pass

Plot 8

Radiated emissions 40 GHz to 60 GHz



Measurement distance d = 0.25 m

Calculation of system attenuation = free space attenuation - antenna gain
a(sys) = a(f) - g
= 28.0 dB

The system attenuation is calculated in the analyser reading.

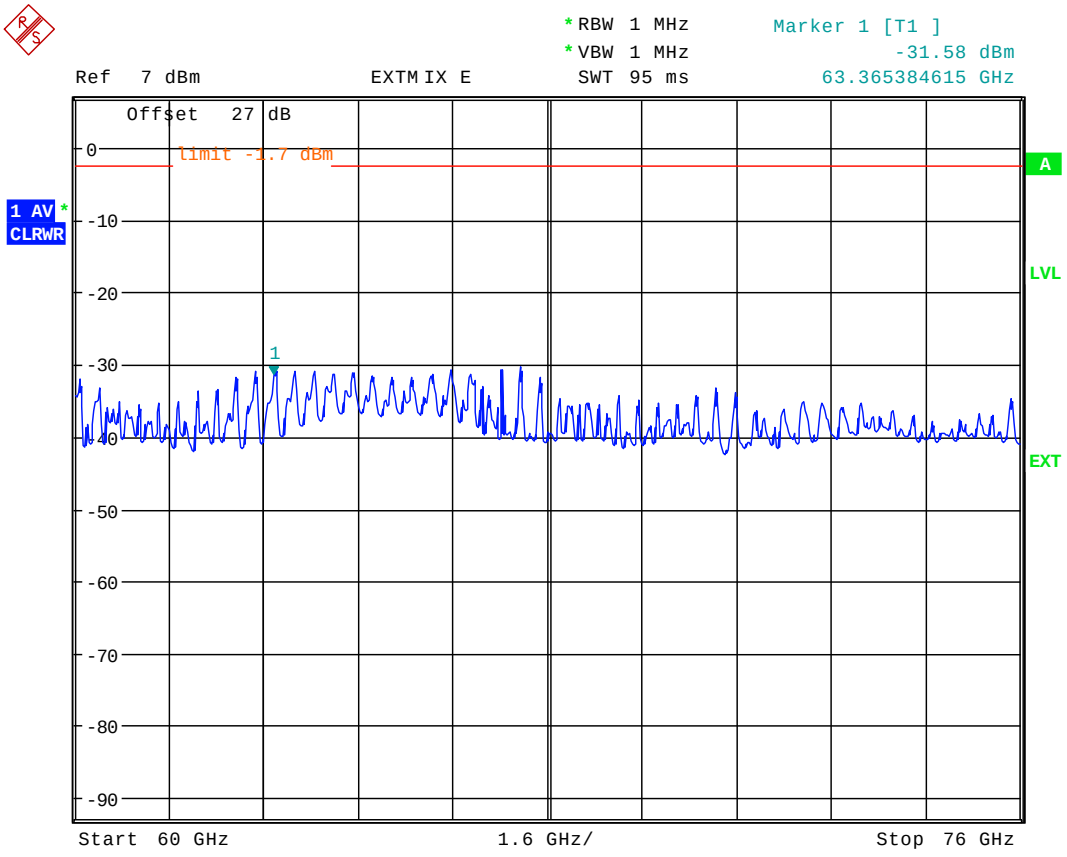
max. value = -49.6 dBm

Limit at 3m = 600 pW/cm^2 = -1.7 dBm at the DUT

Verdict:	pass

Plot 9

Radiated emissions 60 GHz to 76 GHz



Measurement distance d = 0.125 m

Calculation of system attenuation = free space attenuation - antenna gain
a(sys) = a(f) - g
= 27.0 dB

The system attenuation is calculated in the analyser reading.

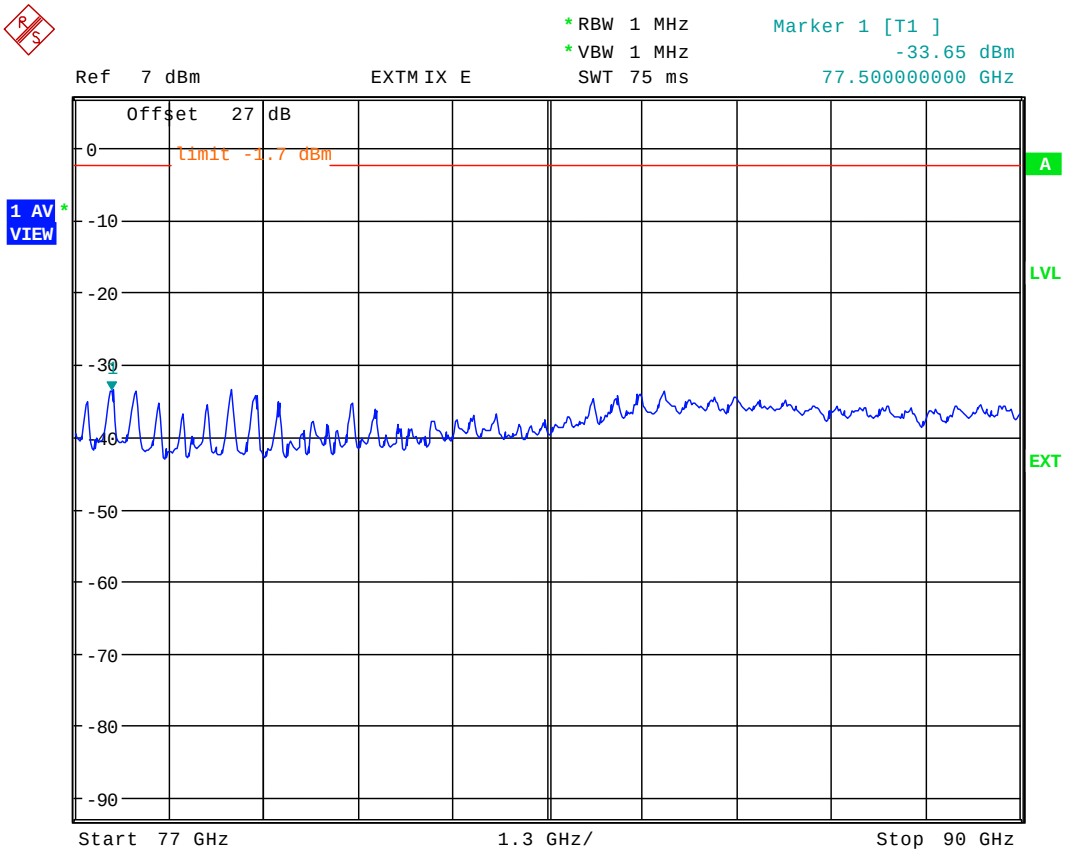
max. value = -31.5 dBm

Limit at 3m = 600 pW/cm^2 = -1.7 dBm at the DUT

Verdict:	pass

Plot 10

Radiated emissions 77 GHz to 90 GHz



Measurement distance d = 0.125 m

Calculation of system attenuation = free space attenuation - antenna gain

a(sys) = a(f) - g

= 27.0 dB

The system attenuation is calculated in the analyser reading.

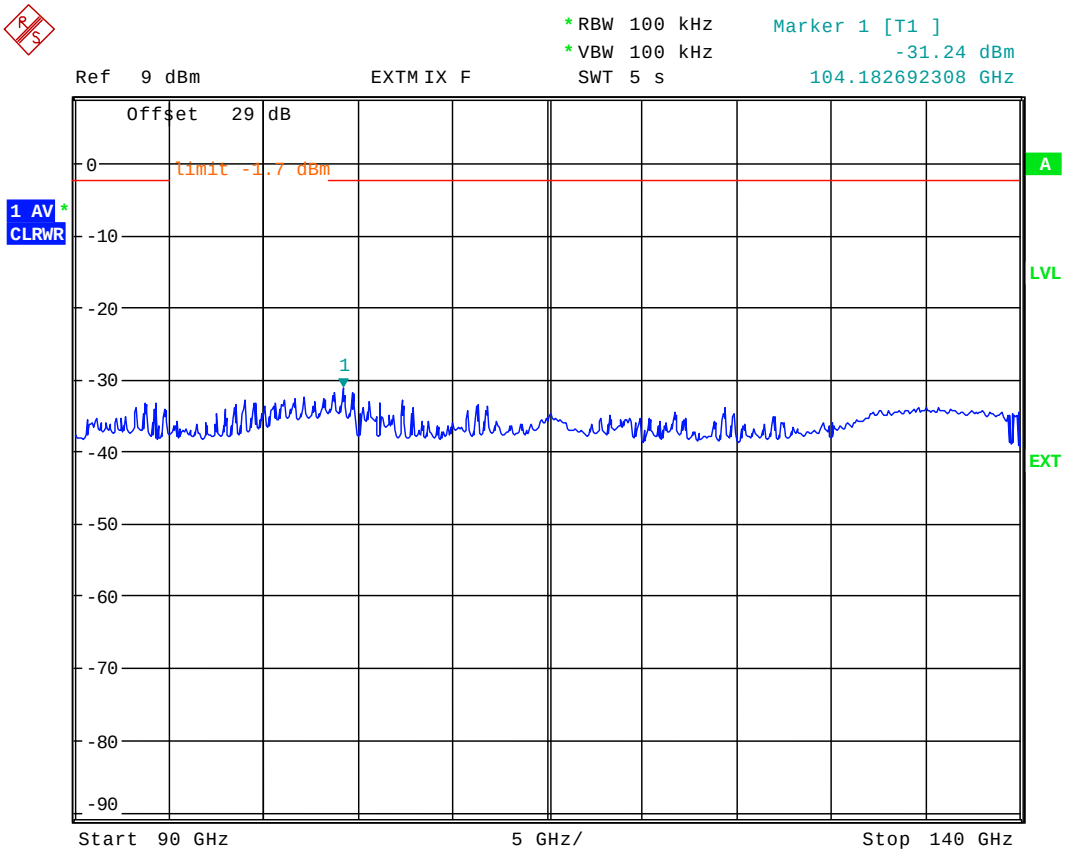
max. value = -33.6 dBm

Limit at 3m = 600 pW/cm^2 = -1.7 dBm at the DUT

Verdict:	pass

Plot 11

Radiated emissions 90 GHz to 140 GHz



For this measurement we used a small filter to increase dynamic range.

Measurement distance d = 0.125 m

Calculation of system attenuation = free space attenuation - antenna gain

a(sys) = a(f) - g

= 29.0 dB

The system attenuation is calculated in the analyser reading.

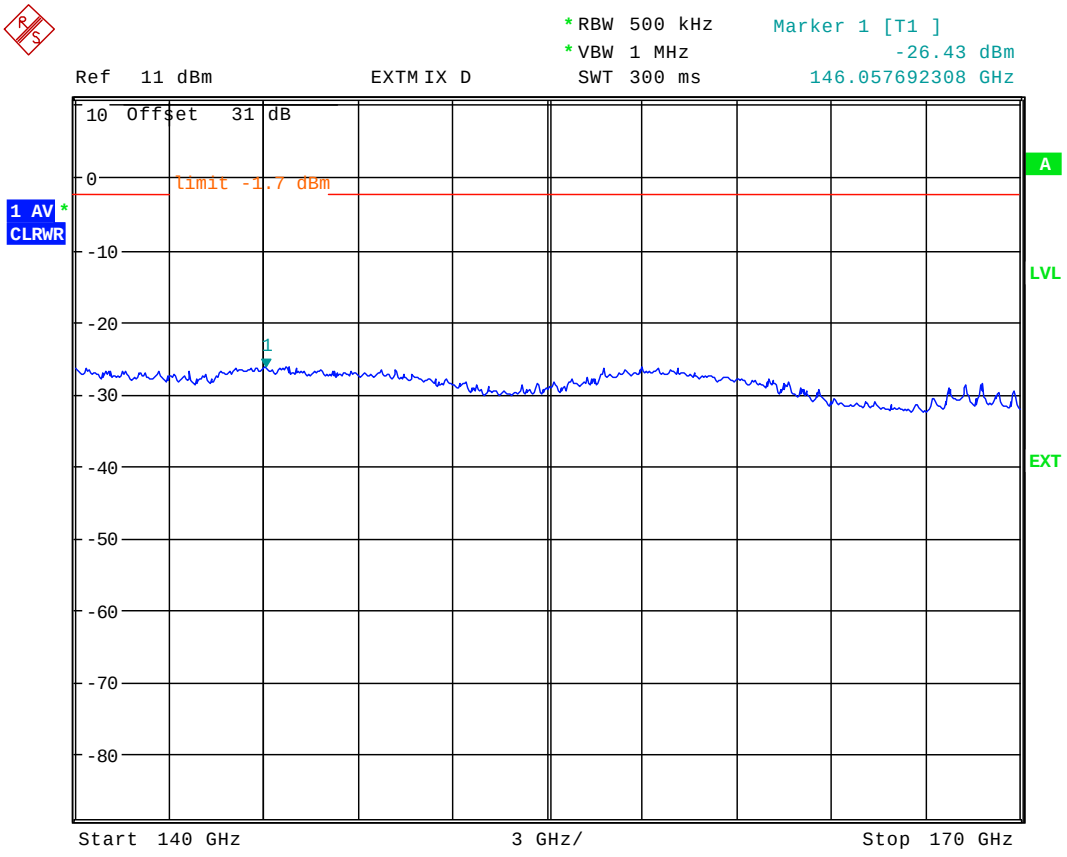
max. value = -31.2 dBm

Limit at 3m = 600 pW/cm^2 = -1.7 dBm at the DUT

Verdict:	pass

Plot 12

Radiated emissions 140 GHz to 170 GHz



For this measurement we used a small filter to increase dynamic range.

Measurement distance d = 0.125 m

Calculation of system attenuation = free space attenuation - antenna gain

a(sys) = a(f) - g

= 31.0 dB

The system attenuation is calculated in the analyser reading.

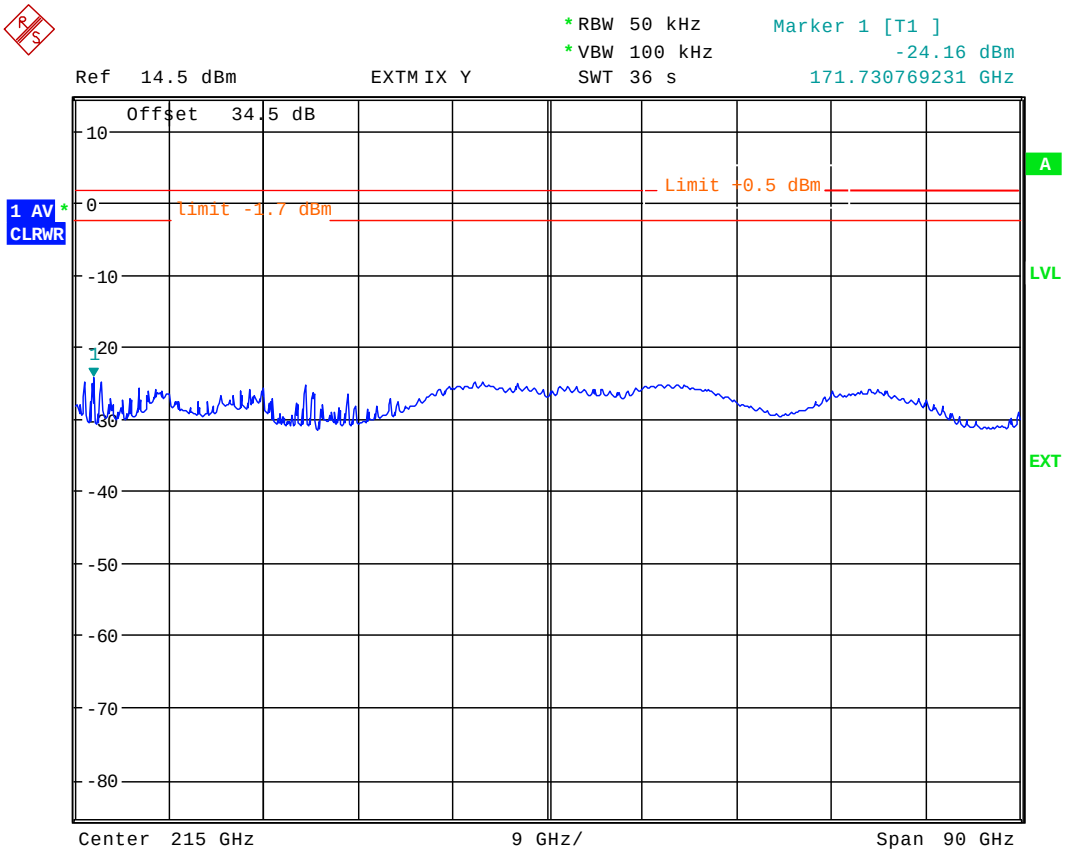
max. value = -26.4 dBm

Limit at 3m = 600 pW/cm^2 = -1.7 dBm at the DUT

Verdict:	pass

Plot 13

Radiated emissions 170 GHz to 260 GHz



For this measurement we used a small filter to increase dynamic range.

Measurement distance d = 0.125 m

Calculation of system attenuation = free space attenuation - antenna gain

a(sys) = a(f) - g

= 34.5 dB

The system attenuation is calculated in the analyser reading.

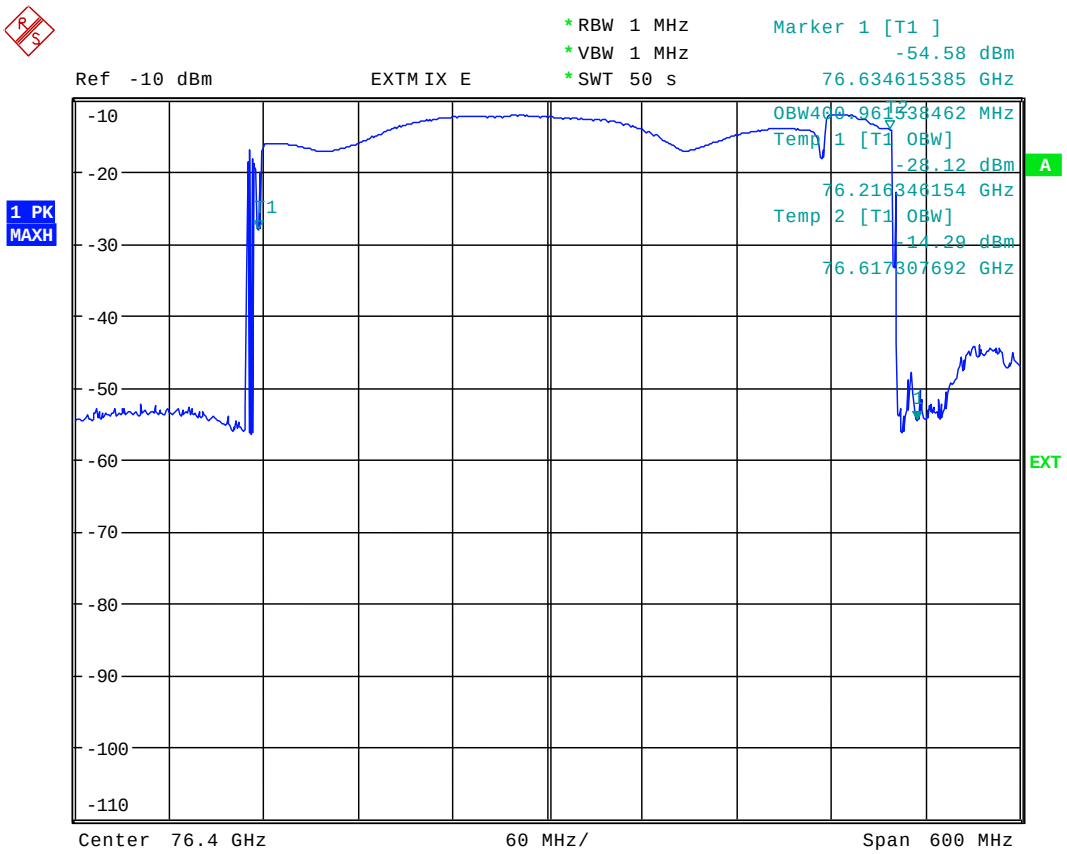
max. value = -24.1 dBm

Limit at 3m (170.0 GHz to 200.0 GHz) = 600 pW/cm^2 = -1.7 dBm at the DUT

Limit at 3m (200.0 GHz to 231.0 GHz) = 1000 pW/cm^2 = +0.5 dBm at the DUT

Verdict:	pass

Plot 14



The occupied frequency range is between 76.216 G Hz and 76.617 GHz.

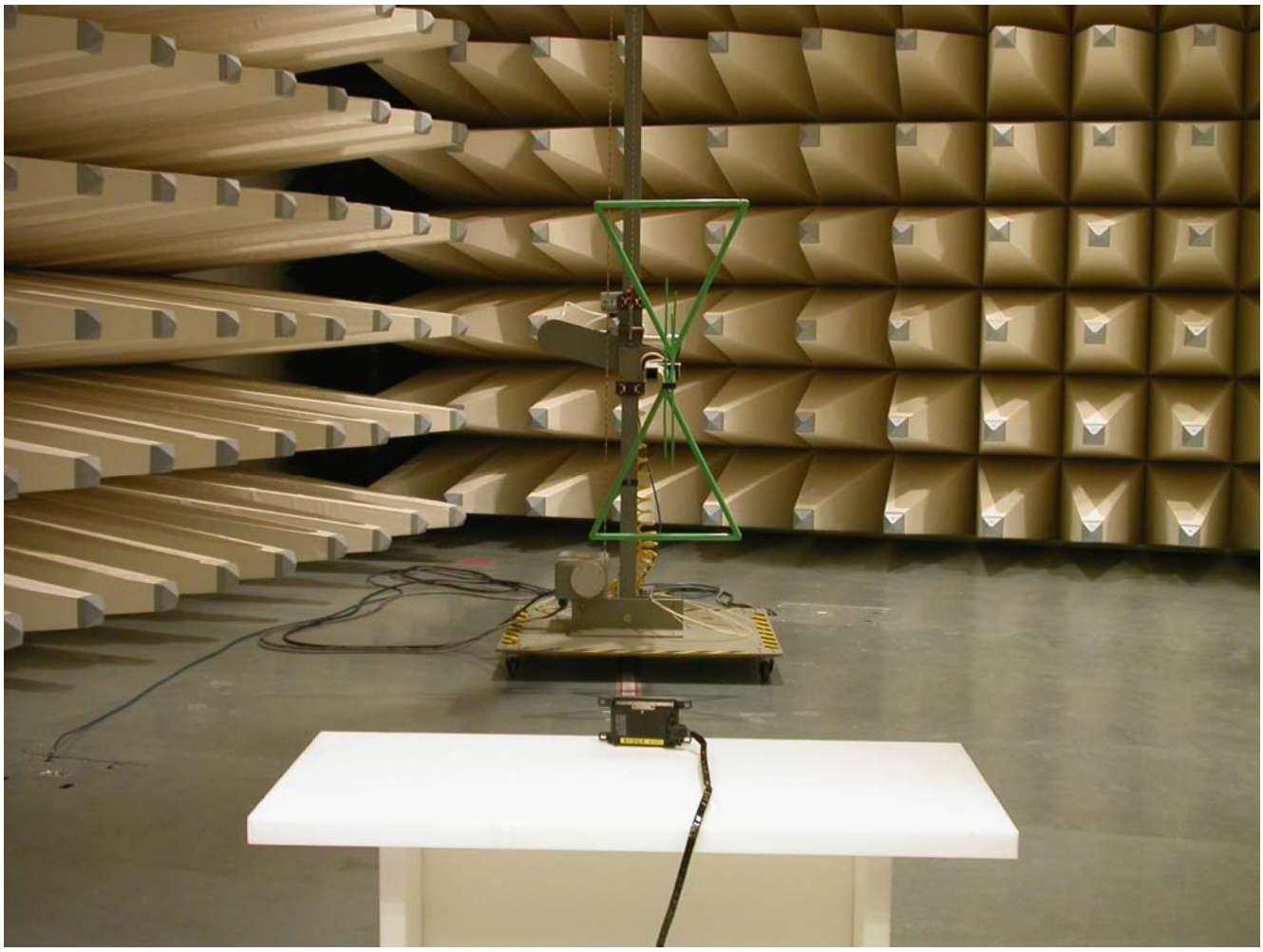
So the ITU designator for this emission is 401MF0N.

Verdict:	pass

4 Photographs

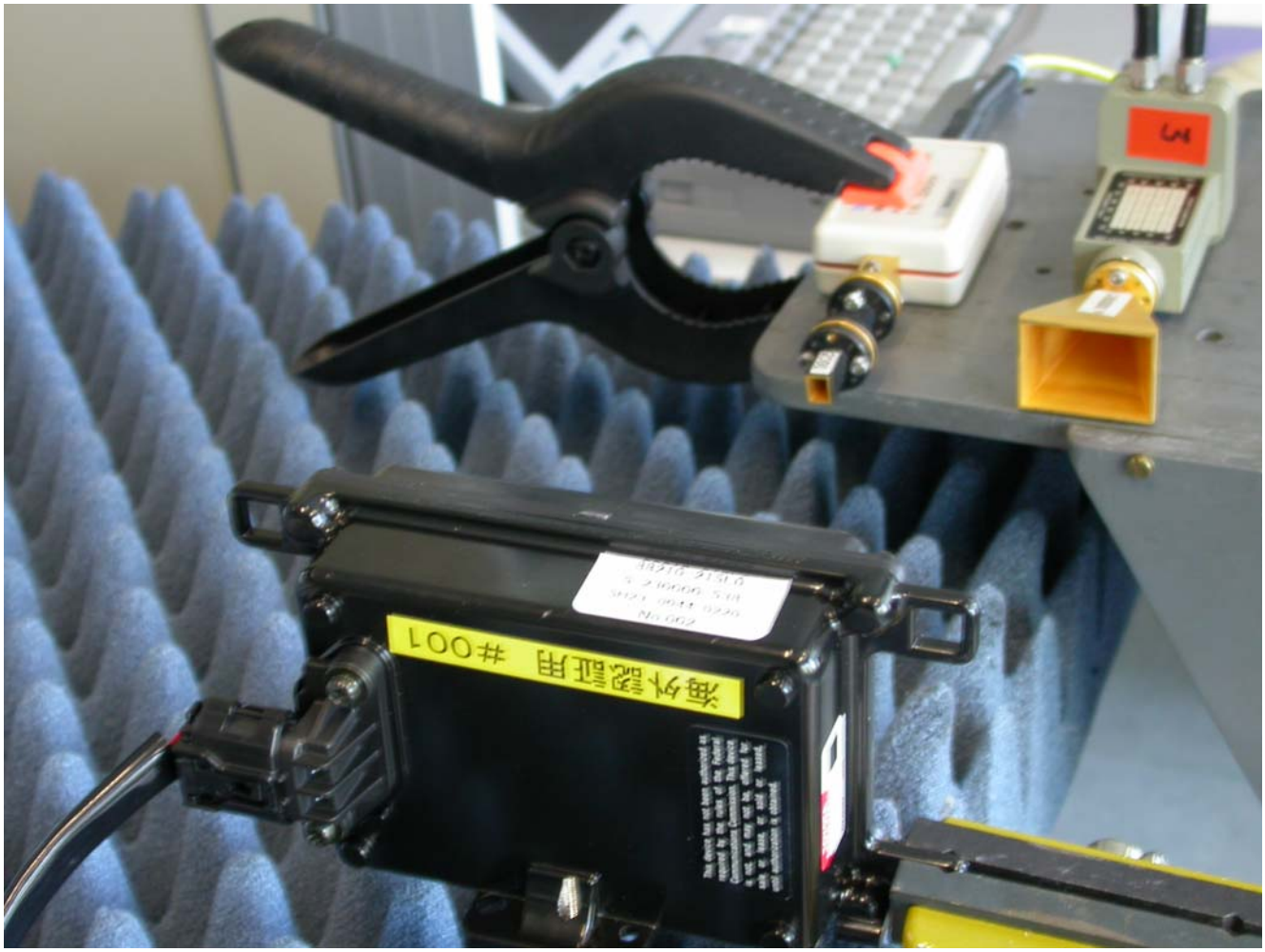
4.1 Photographs of the test set-up

Radiated Emissions up to 1.0 GHz



Radiated Emissions up to 1.0 GHz

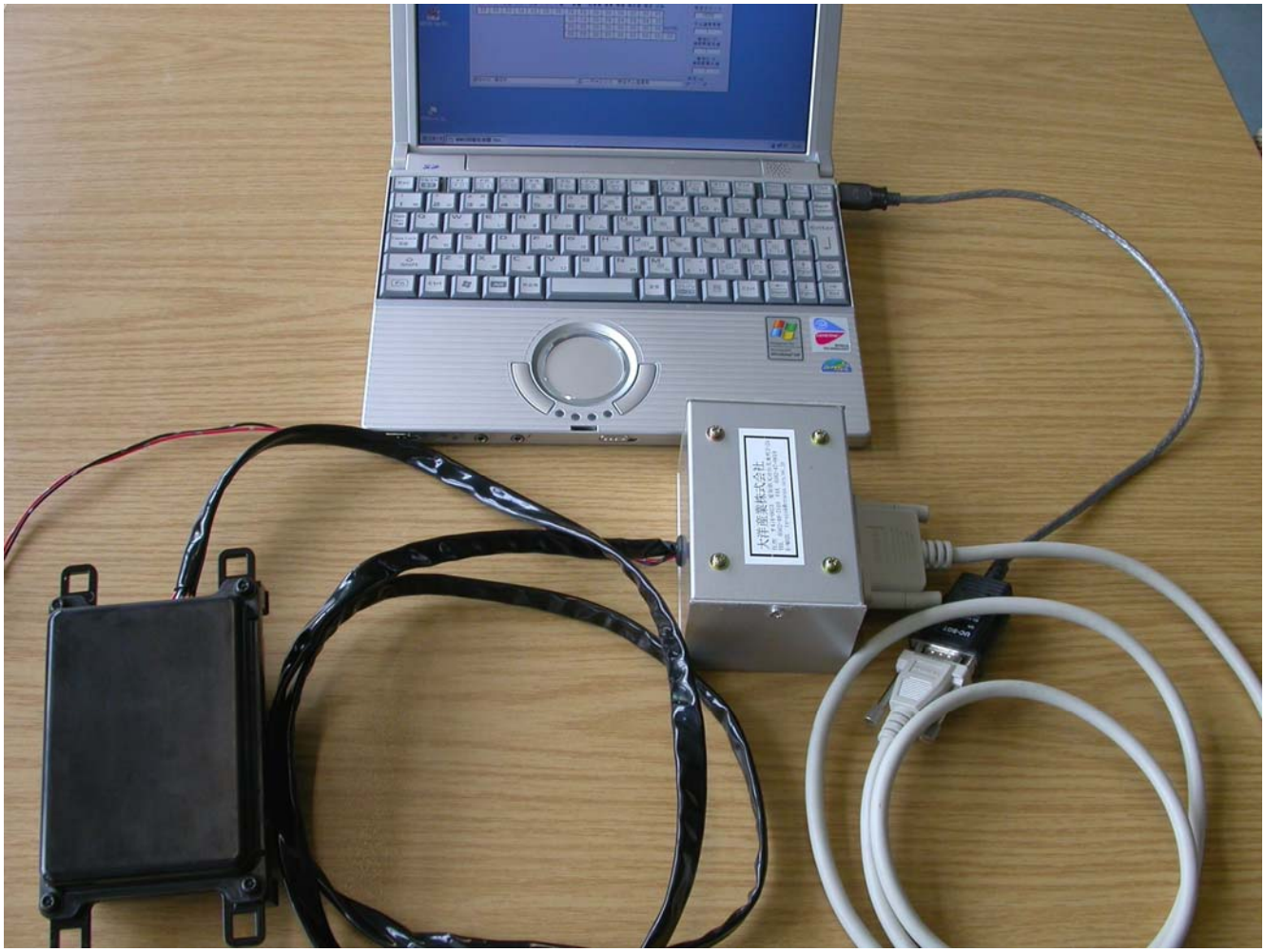
Radiated Emissions

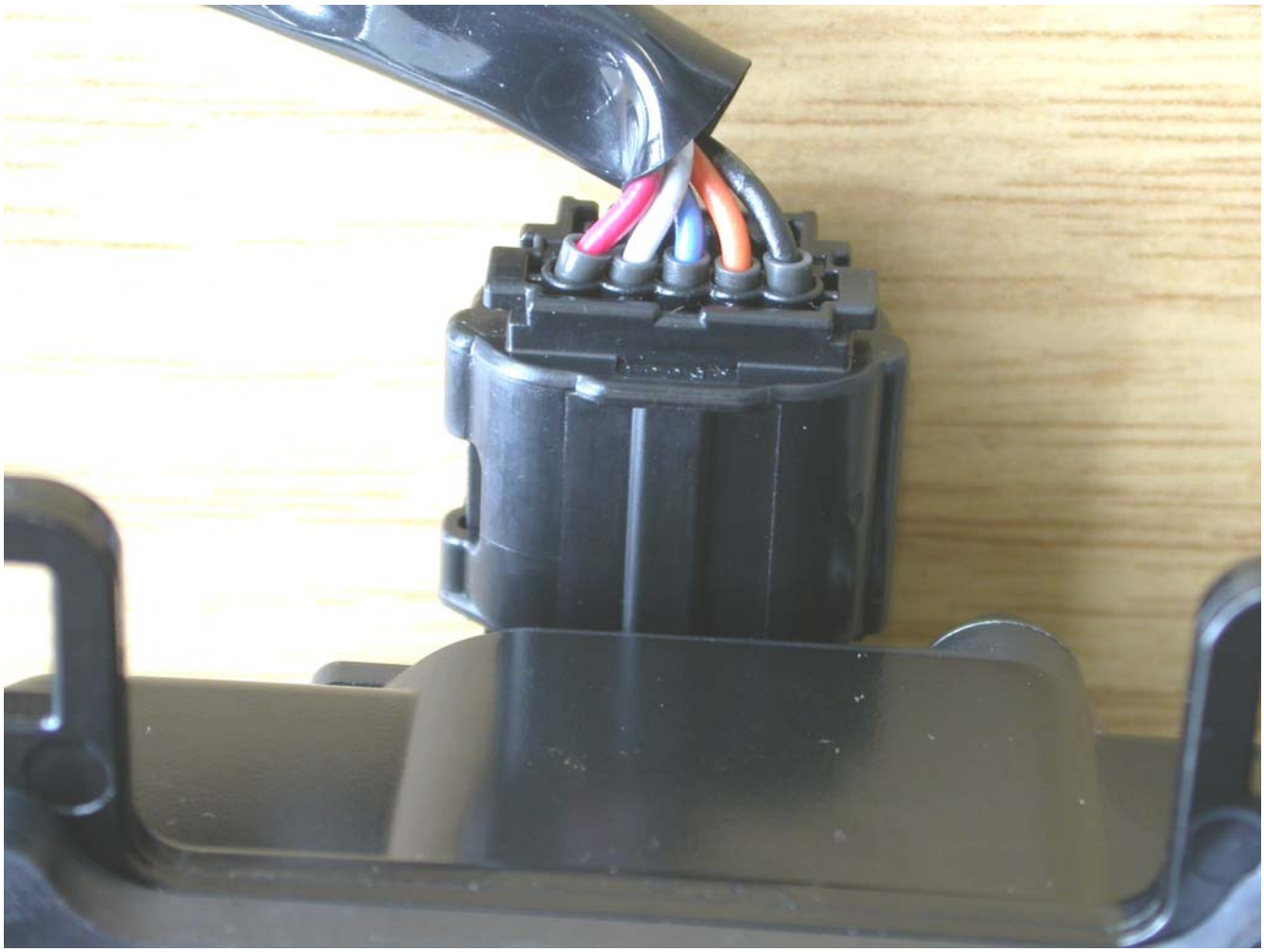


Test set-up


narda
MODEL NO. 638
300000812
Tektronix
WM780W
HARMONIC MIXER
75–110GHz
Tektronix
WM780D
HARMONIC MIXER
110–170GHz
Tektronix
WM780J
HARMONIC MIXER

4.2 Photographs of the EUT



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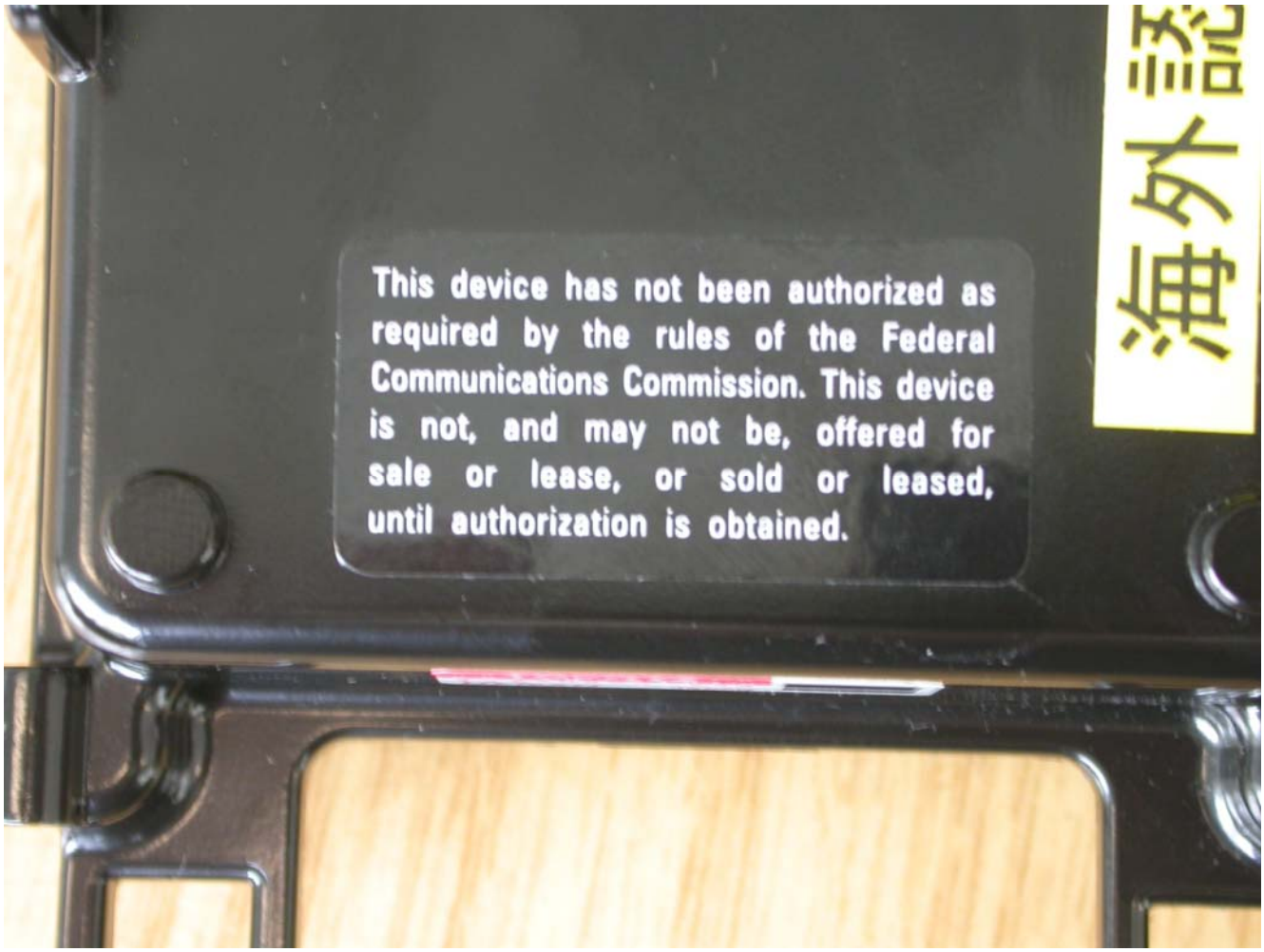
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