CETECOM ICT Services GmbH

Radio Satellite Communication
Untertürkheimer Straße 6–10, D-66117 Saarbrücken, Telephone +49 (0) 681 598 - 0 , Fax +49 (0) 681 598 – 9075

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
TTI–P–G 166/98-30

Independent ETSI
compliance test house

Test report No.: 2-3314-01-01/03
Applicant : DENSO CORPORATION
Type : DNMWR001
Test standard : FCC Part 15

Table of contents

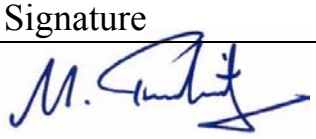
1 General information

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 generalisations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item .

The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of the CETECOM ICT Services GmbH.

Tester :

Date	Name	Signature
31.07.03	Manfred Paschwitz	

Technical responsibility for area of testing:

Date	Name	Signature
31.07.03	Klaus Kammerinke	

1.2 Testing laboratory

CETECOM ICT Services GmbH
Untertürkheimerstraße 6–10 P.O. Box 10 04 45
D-66117 Saarbrücken D-66004 Saarbrücken
Germany Germany

Telephone : + 49 (0) 681 598–0
Fax : + 49 (0) 681 598–9075
e-mail : info@ict.cetecom.de
Internet : http://www.cetecom.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	TTI-P-G 166/98-30
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
Town : Kariya-shi
Country : 448-8661 Japan
Tel. : +81-566-61-7294
Fax : +81-566-25-4683

Contact person
Name : Noriyuki Tomioka
Tel. : +81-566-61-7294
Fax : +81-566-25-4683
e-mail : noriyuki.tomioka/ndj@ndj

1.4 Application details

Date of application : 26.06.2003
Date of receipt of EUT : 29.07.2003
Date of test : 31.07.2003

1.5 Test item (EUT)

Description of EUT	:	Millimeterwave Radar sensor
System designation	:	Mobile (vehicle-mounted) field disturbance sensor
Type designation	:	DNMWR001
Manufacturer	:	Denso Corporation 1-1, Showa-cho Japan

1.6 Technical data

Frequency range	:	76.000 GHz ... 77.000 GHz
Operational frequency	:	76.500 GHz
Power Density (PEP)	:	7.5 µW/cm ^{2}
Type of modulation	:	120M0F0N (FMCW)
Modulation period	:	9.412 ms
Blanking	:	90 ms
Operation	:	TX / RX – Module with integral patch antenna
Antenna modules	:	Integral antennas
Normal power supply	:	13.00 V DC
Extreme power supply	:	10.00 ... 16.00 V DC

1.6.1 Operation conditions

Operation:	:	As soon as the equipment is addressed by Serial-Bus, TX and RX start operating
Purpose of operation	:	Motion detector as distance measuring equipment

1.6.2 Equipment under test

Model	S/N	I/F-Box	PC as controller
DN MWR 001	000001	Serial-Bus	

1.7 Test Standards

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

FCC Part 15	Radio Frequency Devices (03/2003) 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 Radiocommunication Devices Section 6.2.2 (t1) 76.0 - 77.0 GHz Vehicle -Mounted Field Disturbance Sensors Issue 5 of November 30, 2002

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

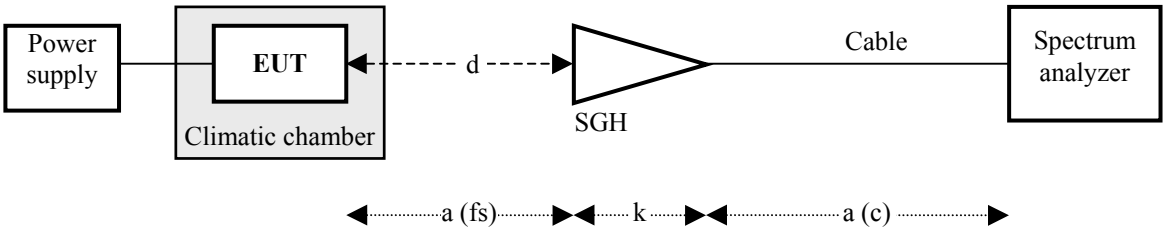
The environmental conditions are documented especially for each test.

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 Field strength and spurious radiation in the frequency range 4 GHz to 40 GHz



Frequency f [GHz]	Distance d [m]	Standard gain Horn ant. (SGH)	Dist. correction. dc (3 m/X m) [dB]	Antenna factor k [dB 1/m]	Cable loss a [dB]
4.0 ... 10.0	0.5	EMCO 3115	-15.56	33.6 ... 38.0	1.8
10.0 ... 20.0	0.5	EMCO 3115	-15.56	38.0 ... 41.5	2.0
18.0 ... 27.0	0.25	narda 638	-21.58	40.4	2.8
27.0 ... 40.0	0.25	narda V637	-21.58	40.8	2.0

Calculation : Field strength = Analyser reading + Cable loss + Antenna factor + Distance correction

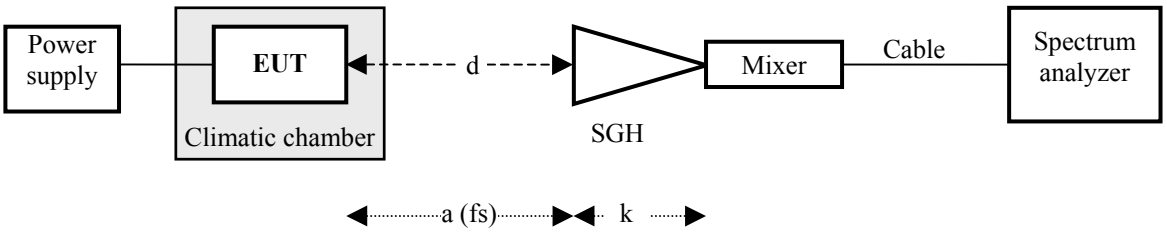
e = u + a + k + dc

Test equipment	Manufacturer	Type	CETECOM reference
Spectrum Analyser	HP	HP 8565E	300001665
SGH 1.0 ... 26.0 GHz	EMCO	3115	300001604
SGH 18 ... 27 GHz	narda	638	300002442
SGH 27 ... 40 GHz	narda	V637	300000510
SGH 27 ... 40 GHz	Thomson	COR 27_40	300000797a
Power supply	HP	6032A	300002115
RF-cable <30 GHz	HP	5061-5359	300002033
RF-cable >30 GHz	Sucoflex	1186/4PA	300002027

Measurement uncertainties

Test parameter	Measurement uncertainty
Power supply	±0.1 VDC
Temperature	±0.2 °C
Frequency	±0.01 ppm
eirp	±1.4 dB

2.4.2 Field strength and spurious radiation in the frequency range 33 GHz to 325 GHz



Frequency f [GHz]	Distance d [m]	Distance correction dc (3 m/Xm) [dB]	Antenna factor k [dB 1/m]	Antenna aperture area A [cm^2]
33 ... 50	0.5	-15.56	38.98	11.6 (10.64 dB)
50 ... 75	0.25	-21.58	40.69	7.92 (8.98 dB)
75 ... 110	0.25	-21.58	45.12	2.85 (4.55 dB)
75 ... 110	3.0	n.a.	45.12	2.85 (4.55 dB)
110 ... 175	0.25	-21.58	49.54	1.03 (0.13 dB)
175 ... 325	0.125	-27.60	54.10 ... 56.22	0.95 (-0.22 dB)

Calculation : Field strength = Analyser reading + Antenna factor + Distance correction
e = u + k + dc

Power density = EIRP / Antenna aperture area
pd = eirp - a

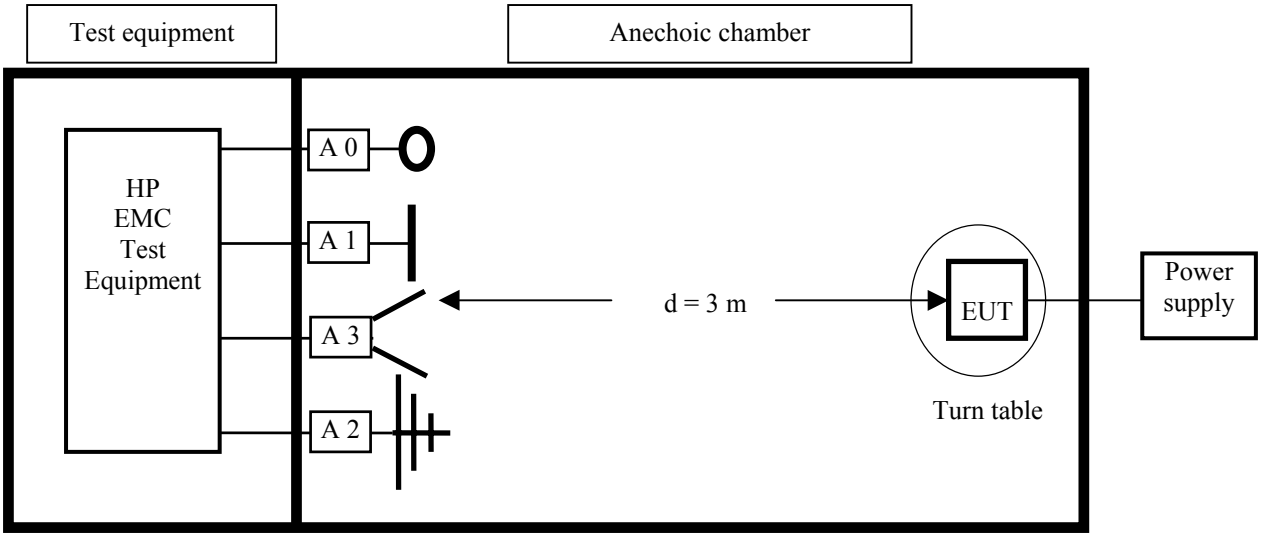
Test equipment	Manufacturer	Type	CETECOM reference
Spectrum Analyser	HP	HP 8565E	300001665
Power supply	HP	6032A	300002115
SGH 33 ... 50 GHz	Thomson	COR 33_50	300000812
Mixer 33 ... 50 GHz	HP	11970Q	300000781i
SGH 50 ... 75 GHz	Thomson	COR 50_75	300000789k
Mixer 50 ... 75 GHz	HP	11970V	300000871o
SGH 75 ... 110 GHz	Thomson	COR 75_110	300000789m
Mixer 75 ... 110 GHz	HP	11970W	300000871v
SGH 110 ... 175 GHz	Thomson	COR 110_175	300000210a
Mixer 110 ... 175 GHz	Tektronix	WM 780 D	B010186
SGH 175 ... 325 GHz	Thomson	COR 175_325	300000210b
Mixer 175 ... 325 GHz	Tektronix	WM 780 J	B010241

Measurement uncertainties

Test parameter	Measurement uncertainty
Power supply	±0.1 VDC
Temperature	±0.2 °C
Frequency	±0.01 ppm
eirp	±1.4 dB (up to 50 GHz)
eirp	±3.0 dB (above 50 GHz)

2.4.3 Field strength and spurious radiation in the frequency range 9 kHz to 4 GHz

Set-up for radiated measurements



Test equipment	Manufacturer	Type	Serial 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
Loop Antenna A 0	R&S	HFH 2–Z2	881 058/42
Biconical antenna A 1	Emco	3104	3758
Log.-per.-antenna A 2	Emco	3146	2304
Double ridge horn ant. A 3	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

Performance	Measurement 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 heads are exchangeable. They are 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 semi-anechoic chambers. 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 C63.2-1987 clause 15 and ANSI C63.4-1992 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 C63-4-1992 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 EUT is FMCW-modulated, with a frequency peak deviation of 120 MHz. Additionally, the EUT is keyed (pulsed) with a TX on time 9.4 ms and a TX off time 90 ms. This modulation scheme can be disabled for test purposes, and then there EUT is operating in CW mode.

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 modulated signal of EUT. Tests are performed with RBW 2.0 and Video bandwidth filter (VBW) 3.0 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 10 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, but the PEP measurement with this setting is incorrect.

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 50 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 stand-by mode (vehicle is not in motion), only the receiver is active and can radiate spurious emission. 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 220 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 4 GHz are carried out in a shielded semi-anechoic test chamber. The measurement distance is 3 m.

In the frequency range 4 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 33 GHz to 325 GHz, spurious frequencies are measured as power densities. For further remarks see section 1.). In order to simplify spurious measurements, the FMCW-modulation is disabled, and the EUT is operating as a CW transmitter. The RBW and VBW are set to such a value that spurious power levels clearly are readable above fundamental noise level.

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: FMCW and normal pulse mode. The measurement is performed at 5 different distances: 4 m, 2 m, 1 m, 0.5 m, and 0.25 m. See ETSI test report 2-3314-01-02/03 page 15.

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 7.5 $\mu W/cm^2$ (-21.25 $dBmW/cm^2$).

Peak Power (EIRP)

$$EIRP = PD * 4\pi * R^2$$
$$EIRP = 8.482 \text{ W (Peak)}$$

This is a PEP value which must be multiplied with the duty cycle correction factor (dcc) in order to get the average value. With t on = 9.412 ms, and t off = 90 ms.

$$dcc = 20 * \log (t\ on / t\ off)$$
$$dcc = -19.61 \text{ dB}$$

Average power (EIRP)

$$eirp = 10 \log (EIRP\ Peak) - dcc$$
$$eirp = -10.32 \text{ dBW}$$
$$EIRP = 92.789 \text{ mW}$$

Limit of maximum ERP for frequencies above 1.5 GHz is 3 W. See FCC § 2.1091

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

$$PD = EIRP\ average / (4\pi * R^2)$$
$$PD = 0.0184 \text{ mW/cm}^2$$

Limit of maximum permissible exposure (MPE) for uncontrolled environment:1.0 mW/cm^2. See FCC § 1.1310.

2.5.3 Test results according to FCC in details

Equipment under test (EUT) : DNMWR001
Ambient temperature : 23 °C
Relative humidity : 55 %

TRANSMITTER PARAMETERS SECTION 15.253

FUNDAMENTAL FREQUENCY SECTION 15.253 (2)

76.000 GHz to 77.000 GHz

Operation : Vehicle in motion
Antenna assembly: Fixed integral patch antennas

TEST CONDITIONS T = - 20.0 ° C	TRANSMITTER POWER DENSITY			
EUT operating: TX on and RX on	Low Frequency f [GHz]	High Frequency f [GHz]	Power Density PD [µW/cm ^{2}]	See plot on page
U DC = 10.0 V	76.174 550	76.309 150	1.811 / 2.630	21 / 22
U DC = 11.0 V	76.174 560	76.308 850		-
U DC = 12.0 V	76.174 650	76.309 050		-
U DC = 13.0 V	76.176 750	76.308 650	7.498	23
U DC = 14.0 V	76.175 550	76.308 750		-
U DC = 15.0 V	76.174 580	76.308 950		-
U DC = 16.0 V	76.174 550	76.309 150	1.811 / 2.630	24, 25

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 9

LIMITS: SECTION 15.253

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) : DNMWR001
Ambient temperature : 23 °C
Relative humidity : 55 %

TRANSMITTER PARAMETERS SECTION 15.253

FUNDAMENTAL FREQUENCY SECTION 15.253 (2)

76.000 GHz to 77.000 GHz

Operation : Vehicle in motion
Antenna assembly: Fixed integral patch antennas

TEST CONDITIONS T = 23.0 ° C	TRANSMITTER POWER DENSITY			
EUT operating: TX on and RX on	Low Frequency f [GHz]	High Frequency f [GHz]	Power Density PD [µW/cm ^{2}]	See plot on page
U DC = 10.0 V	76.173 700	76.293 800	1.612	26
U DC = 11.0 V	76.173 500	76.293 600		-
U DC = 12.0 V	76.173 300	76.293 400		-
U DC = 13.0 V	76.172 700	76.293 000	1.614	26
U DC = 14.0 V	76.173 200	76.293 500		-
U DC = 15.0 V	76.173 600	76.293 400		-
U DC = 16.0 V	76.173 400	76.293 200	1.628	26

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 9

LIMITS: SECTION 15.253

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) : DNMWR001
Ambient temperature : 23 °C
Relative humidity : 55 %

TRANSMITTER PARAMETERS SECTION 15.253

FUNDAMENTAL FREQUENCY SECTION 15.253 (2)

76.000 GHz to 77.000 GHz

Operation : Vehicle in motion
Antenna assembly: Fixed integral patch antennas

TEST CONDITIONS T = 50.0 ° C	TRANSMITTER POWER DENSITY			
EUT operating: TX on and RX on	Low Frequency f [GHz]	High Frequency f [GHz]	Power Density PD [µW/cm ^{2}]	See plot on page
U DC = 10.0 V	76.219 700	76.343 830	3.935 / 1.778	27 / 28
U DC = 11.0 V	76.220 500	76.343 630		-
U DC = 12.0 V	76.219 800	76.343 230		-
U DC = 13.0 V	76.220 100	76.343 130	5.956	29
U DC = 14.0 V	76.220 400	76.343 730		-
U DC = 15.0 V	76.220 500	76.343 530		-
U DC = 16.0 V	76.219 700	76.343 830	3.935 / 1.778	30 / 31

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 9

LIMITS: SECTION 15.253

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) : DNMWR001
Ambient temperature : 23 °C
Relative humidity : 55 %

TRANSMITTER PARAMETERS SECTION 15.253

EMISSIONS IN STAND BY OPERATION SECTION 15.253 (1)

76.000 GHz to 77.000 GHz

Operation : Vehicle standing
Antenna assembly: Fixed integral patch antennas

TEST CONDITIONS T = - 20.0 ° C TO + 50,0 ° C	TRANSMITTER POWER DENSITY			
EUT operating: RX on	Frequency f [GHz]	S A p [dBm]	Power Density PD [nW/cm ^{2}]	See plot on page
U DC = 10.0 V	76.0 ... 77.0	Noise	<< limit	-
U DC = 11.0 V	76.0 ... 77.0	Noise	<< limit	-
U DC = 12.0 V	76.0 ... 77.0	Noise	<< limit	-
U DC = 13.0 V	76.0 ... 77.0	Noise	33.113	32
U DC = 14.0 V	76.0 ... 77.0	Noise	<< limit	-
U DC = 15.0 V	76.0 ... 77.0	Noise	<< limit	-
U DC = 16.0 V	76.0 ... 77.0	Noise	<< limit	-

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 9

LIMITS: SECTION 15.253

Frequency range [GHz] vehicle not in motion	Measurement distance [m]	Power density pd [dbmW/cm^2]	Power Density PD [nW/cm ^{2}]
76.0 to 77.0	3.0	-36.9	200

Verdict :	Power Density limit is kept

EUT : DNMWR001
Ambient temperature : 23 °C
Relative humidity : 55 %

TRANSMITTER PARAMETERS SECTION 15.253

SPURIOUS FREQUENCIES SECTION 15.209
In the frequency range 9 kHz to 4 GHz

Operation : Vehicle in motion
Antenna assembly: Fixed integral patch antennas

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) horizontal plane	0.380	40.8	109.64	33
0.009 – 30.000 (v) vertical plane	0.035	42.9	139.63	34
25 – 4,000 (h + v)	Noise	< limit	< limit	35 / 39
25 – 4,000 (h + v)	Noise	< limit	< limit	36
25 – 4,000 (h + v)	Noise	< limit	< limit	37
25 – 4,000 (h + v)	Noise	< limit	< limit	38

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

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

EUT : DNMWR001
Ambient temperature : 23 °C
Relative humidity : 55 %

TRANSMITTER PARAMETERS SECTION 15.253

SPURIOUS FREQUENCIES SECTION 15.209
In the frequency range 4 GHz to 40 GHz

Operation : Vehicle in motion
Antenna assembly: Fixed integral patch antennas

TEST CONDITIONS		TRANSMITTER SPURIOUS FIELD STRENGTH				
Frequency range [GHz]		Spurious frequencies [GHz]	RBW [MHz]	S A e [dBµV/m]	E [µV/m]	See plot on page
4.0 – 10.0	(h + v)	Noise	0.100	48.17	256.15	40
10.0 – 20.0	(h + v)	Noise	0.100	50.94	352.37	41
18.0 – 27.0	(h + v)	Noise	0.100	49.14	286.41	42
27.0 – 40.0	(h + v)	Noise	0.100	53.55	475.88	43
9.4 - 9.6	(h + v)	L.O. = 9.523	0.100	47.15	227.77	44

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 8

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

EUT : DNMWR001
Ambient temperature : 23 °C
Relative humidity : 55 %

TRANSMITTER PARAMETERS SECTION 15.253

SPURIOUS FREQUENCIES SECTION 15.209
In the frequency range 33 GHz to 325 GHz

Operation : Vehicle in motion
Antenna assembly: Integral patch antenna

TEST CONDITIONS		TRANSMITTER SPURIOUS POWER DENSITY				
Frequency range [GHz]		Spurious frequencies [GHz]	RBW [MHz]	S A pd [dBmW/cm^2]	PD [pW/cm^2]	See plot on page
33.0 – 50.0	(h + v)	> 40	1.000	-78.47	<< limit	45
50.0 – 75.0	(h + v)	Noise	1.000	-65.65	272.27	46
75.0 – 76.0	(h + v)	Noise	1.000	-76.93	<< limit	47
77.0 – 80.0	(h + v)	Noise	1.000	-75.83	<< limit	48
80.0 – 110.0	(h + v)	Noise	1.000	-74.67	<< limit	49
110.0 - 170.0	(h + v)	Noise	1.000	-64.28	456.03	50
140.0 - 220.0	(h + v)	Noise	1.000	-80.36	<< limit	51
220.0 - 325.0	(h + v)	Noise	1.000	-60.93	849.18	52

REFERENCE OF TEST EQUIPMENT USED : see test set-up on page 9

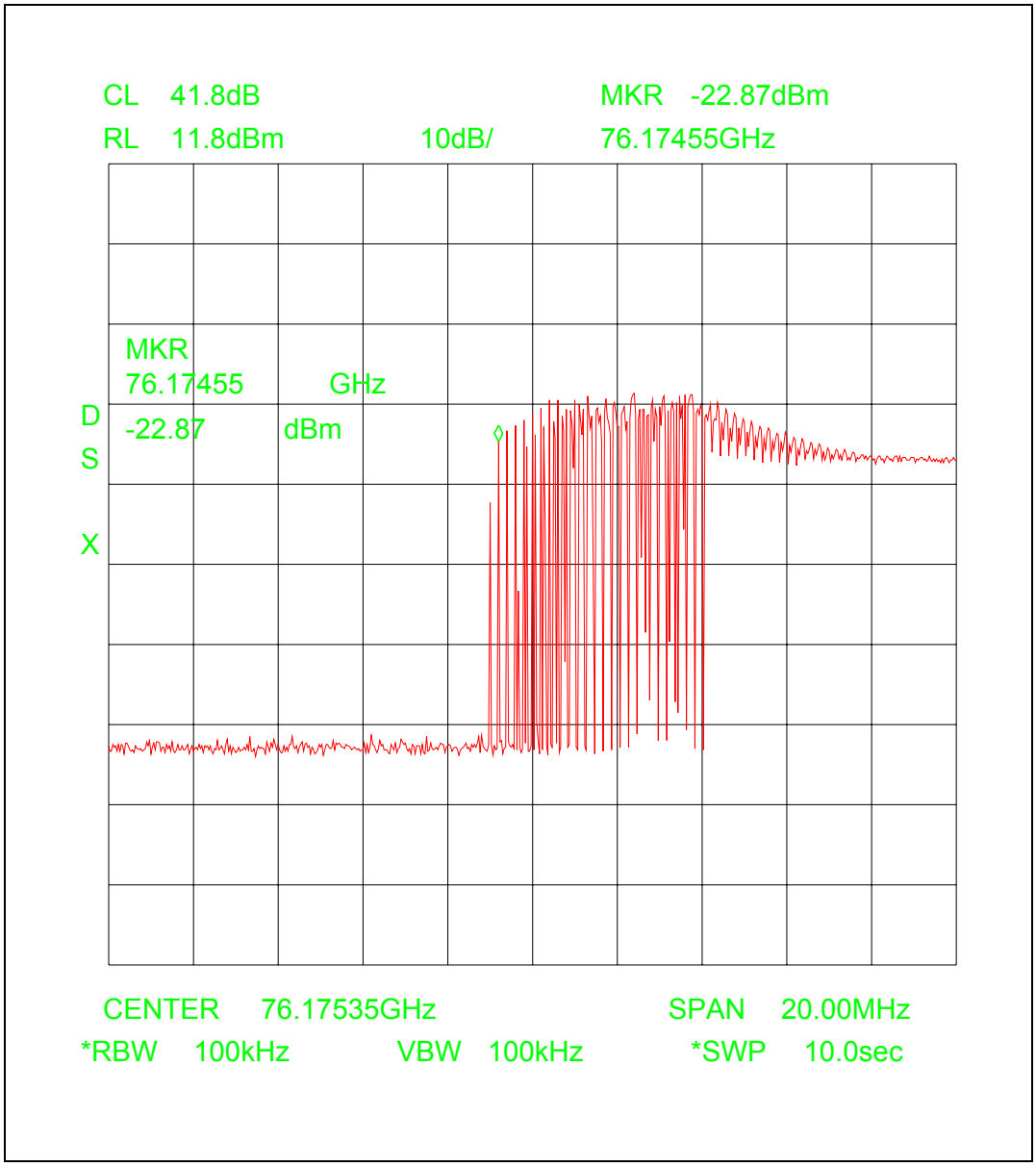
LIMITS: SECTION 15.253 / 15.205 / 15.209

Frequency range (MHz)	Measurement distance [m]	Power density pd [dB(mW/ cm^2)]	Power density PD [pW/ cm^2]
40.0 GHz - 200 GHz	3	-62.2	600
200 GHz - 231 GHz	3	-60.0	1000

Verdict :	Power density limits are kept

3. Plots, graphs and data sheets

Plot 1



Measurement distance d = 3.0 m

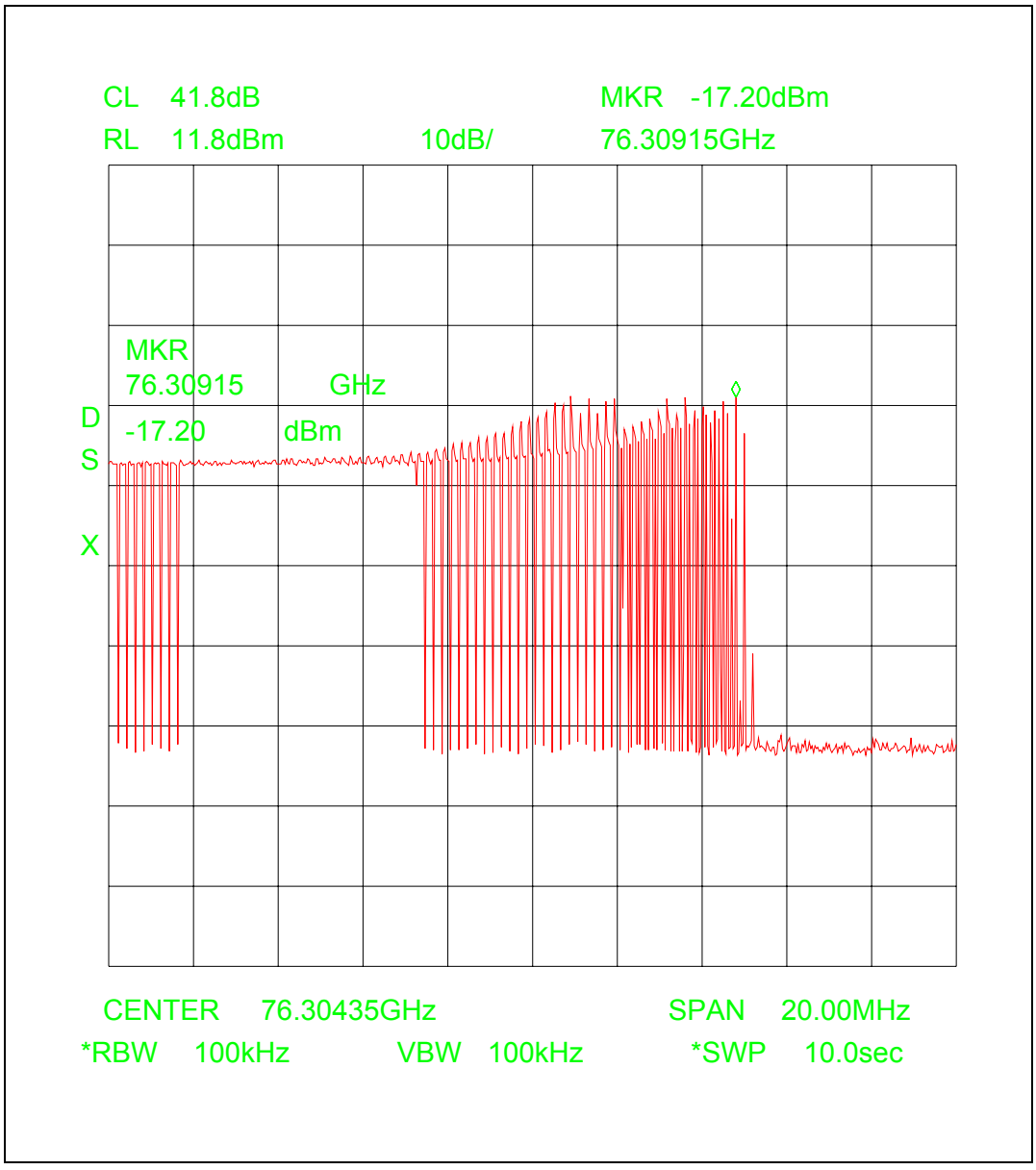
Calculation : Power density = EIRP / Antenna aperture area

pd = -22.87 dBm - 4.55 dB(cm^2)

pd = -27.42 dB(mW/cm^2)

PD = 1.811 $\mu W/cm^2$

Plot 2



Measurement distance d = 3.0 m

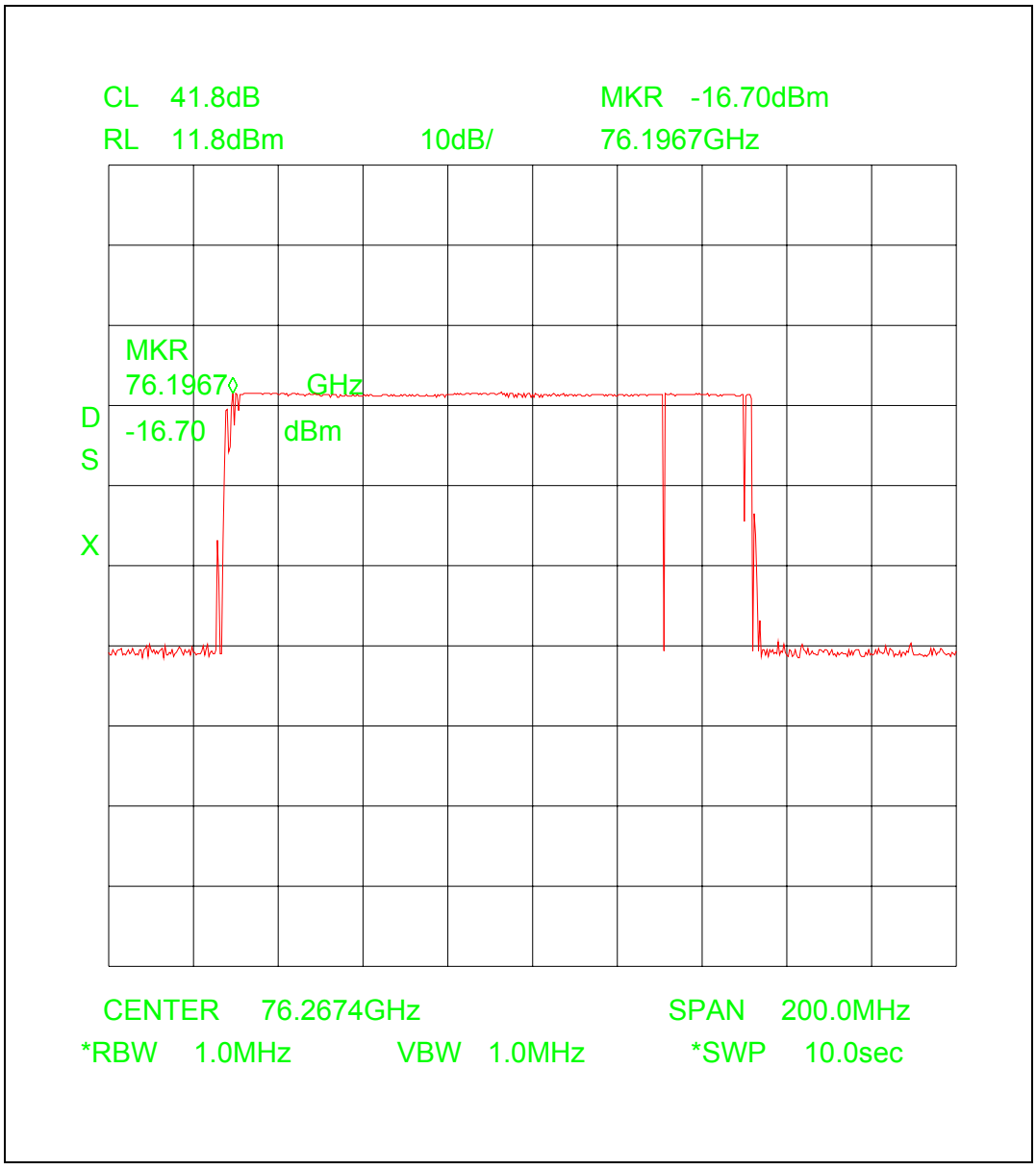
Calculation : Power density = EIRP / Antenna aperture area

pd = -21.25 dBm - 4.55 dB(cm^2)

pd = -25.80 dB(mW/cm^2)

PD = 2.630 $\mu W/cm^2$

Plot 3



Measurement distance d = 3.0 m Analyser reading: 26.75 dBmV = -20.25 dBm

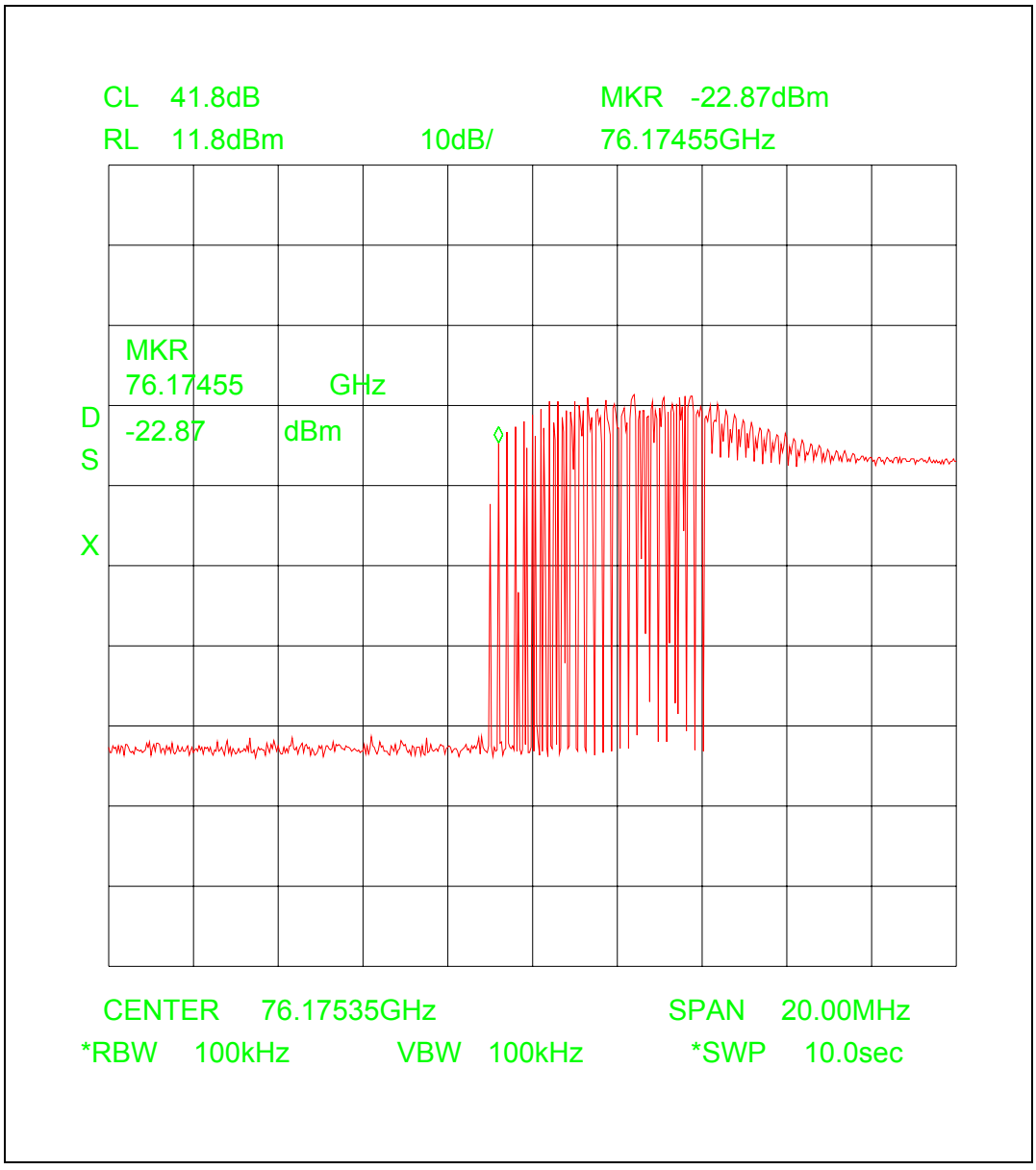
Calculation : Power density = EIRP / Antenna aperture area

pd = -16.7 dBm - 4.55 dB(cm^2)

pd = -21.25 dB(mW/cm^2)

PD = 7.498 $\mu W/cm^2$

Plot 4



Measurement distance d = 3.0 m

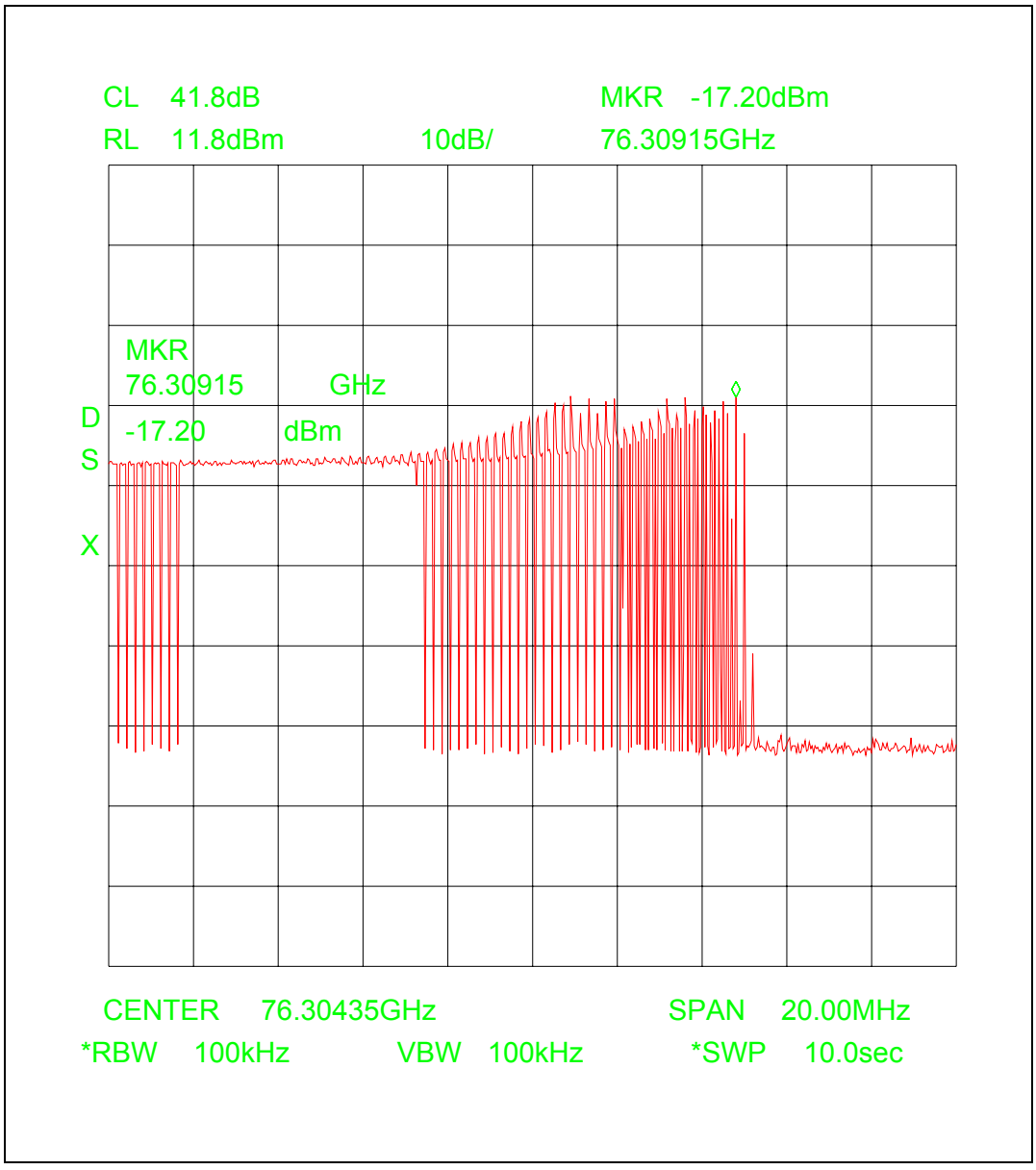
Calculation : Power density = EIRP / Antenna aperture area

pd = -22.87 dBm - 4.55 dB(cm^2)

pd = -27.42 dB(mW/cm^2)

PD = 1.811 $\mu W/cm^2$

Plot 5



Measurement distance d = 3.0 m

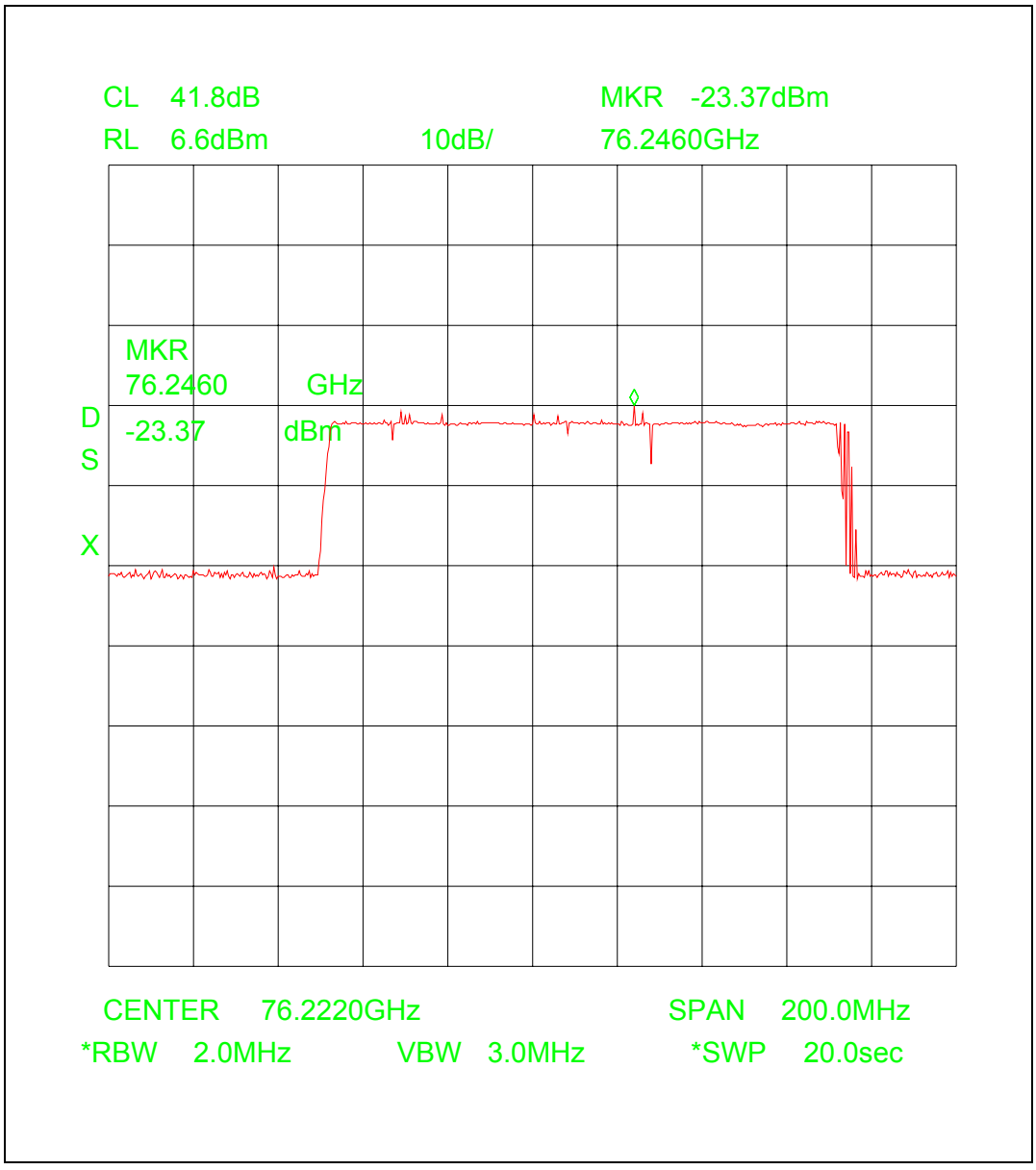
Calculation : Power density = EIRP / Antenna aperture area

pd = -21.25 dBm - 4.55 dB(cm^2)

pd = -25.80 dB(mW/cm^2)

PD = 2.630 $\mu W/cm^2$

Plot 6



Measurement distance d = 3.0 m

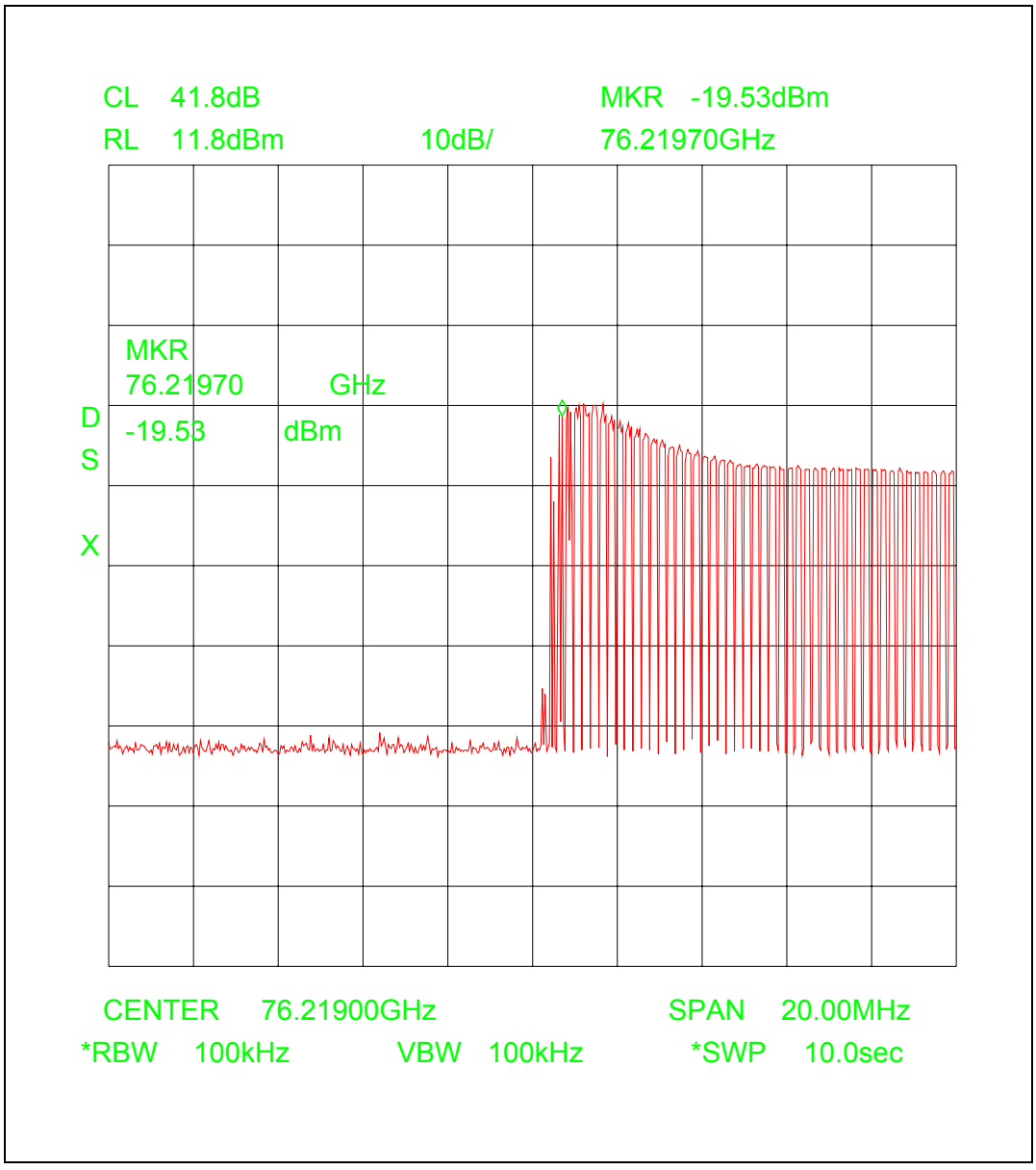
Calculation : Power density = EIRP / Antenna aperture area

pd = -23.37 dBm - 4.55 dB(cm^2)

pd = -27.92 dB(mW/cm^2)

PD = 1.614 $\mu W/cm^2$

Plot 7



Measurement distance d = 3.0 m

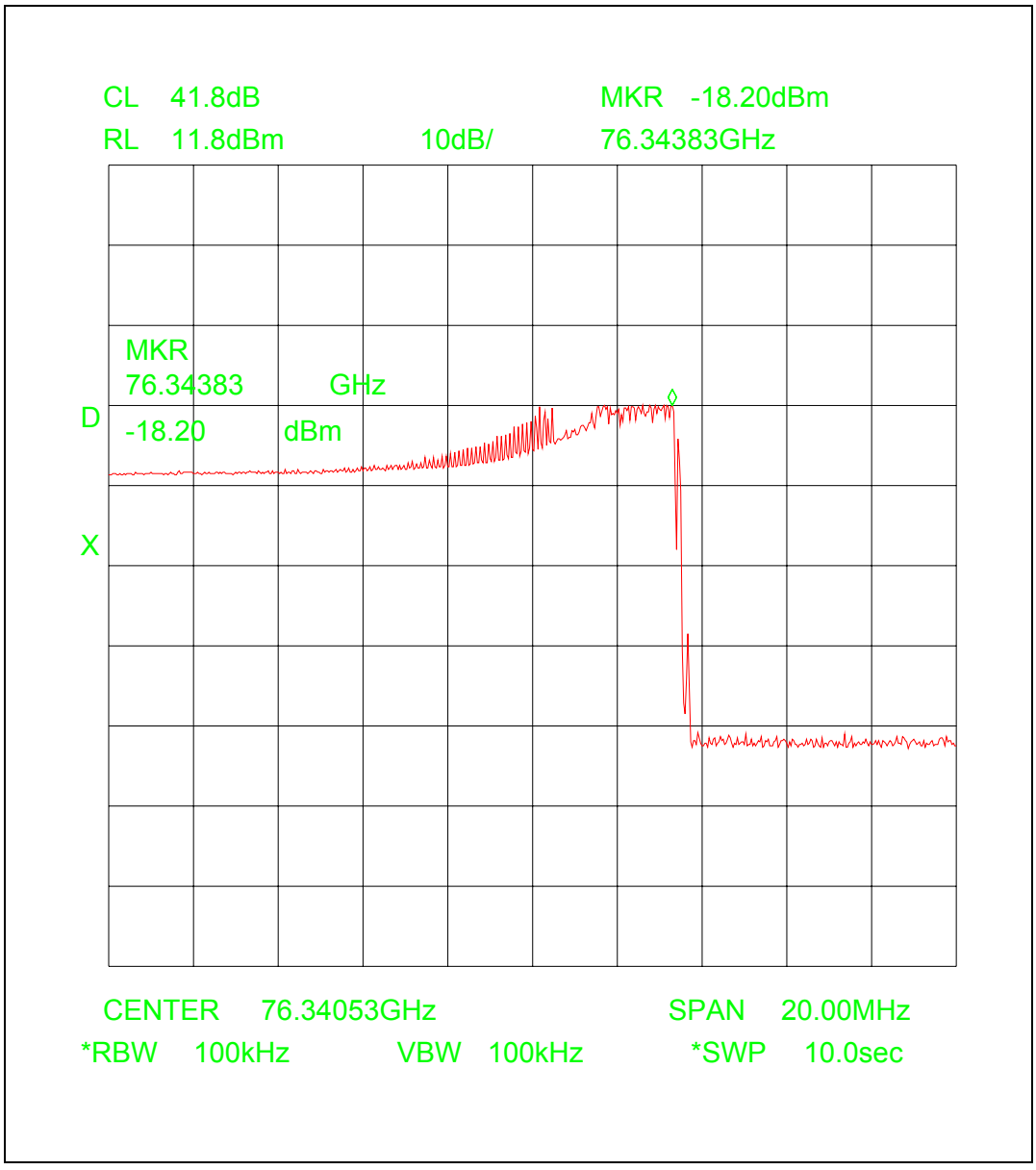
Calculation : Power density = EIRP / Antenna aperture area

pd = -19.5 dBm - 4.55 dB(cm^2)

pd = -24.05 dB(mW/cm^2)

PD = 3.935 $\mu W/cm^2$

Plot 8



Measurement distance d = 3.0 m

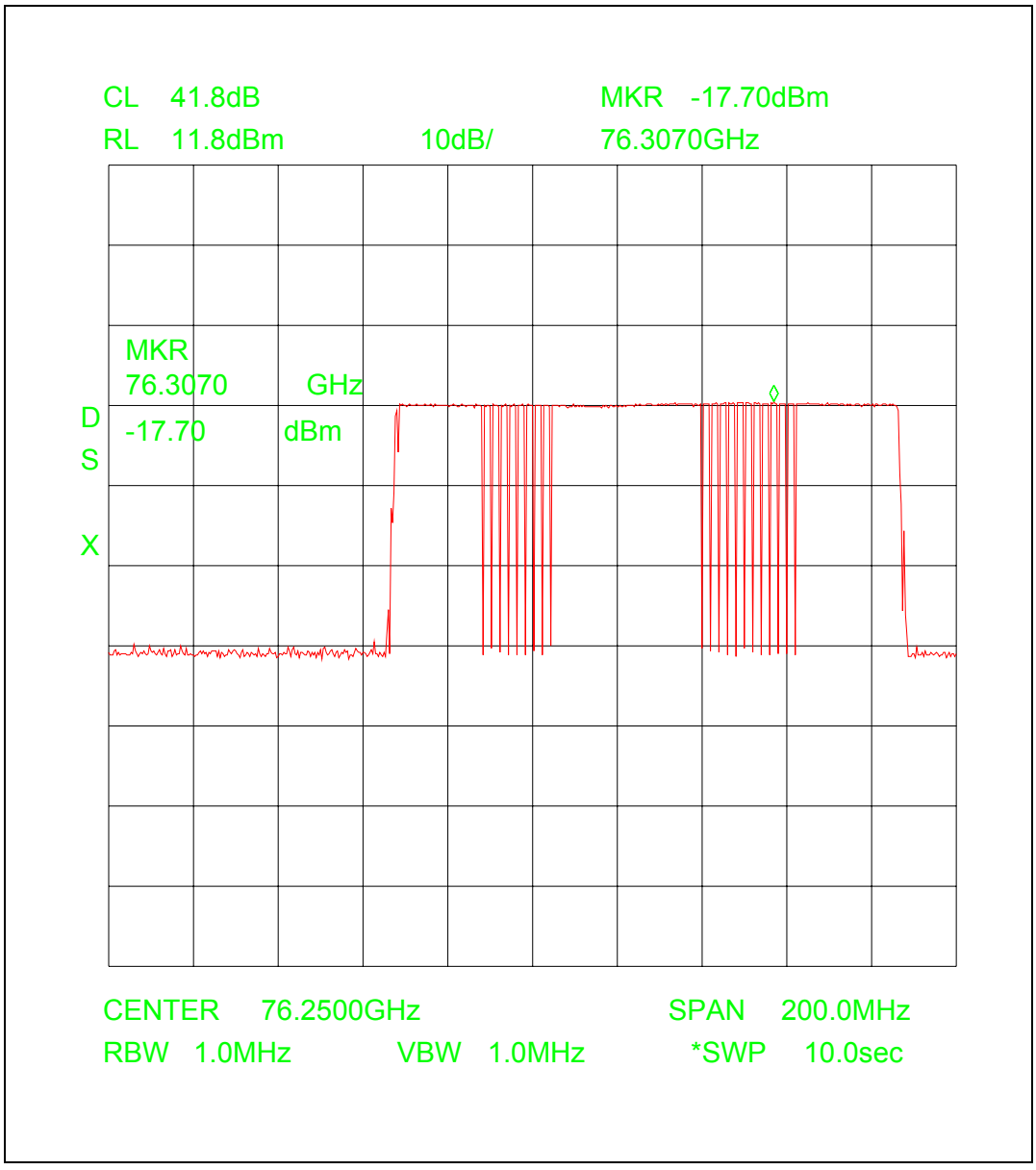
Calculation : Power density = EIRP / Antenna aperture area

pd = -18.2 dBm - 4.55 dB(cm^2)

pd = -22.75 dB(mW/cm^2)

PD = 1.778 $\mu W/cm^2$

Plot 9



Measurement distance d = 3.0 m

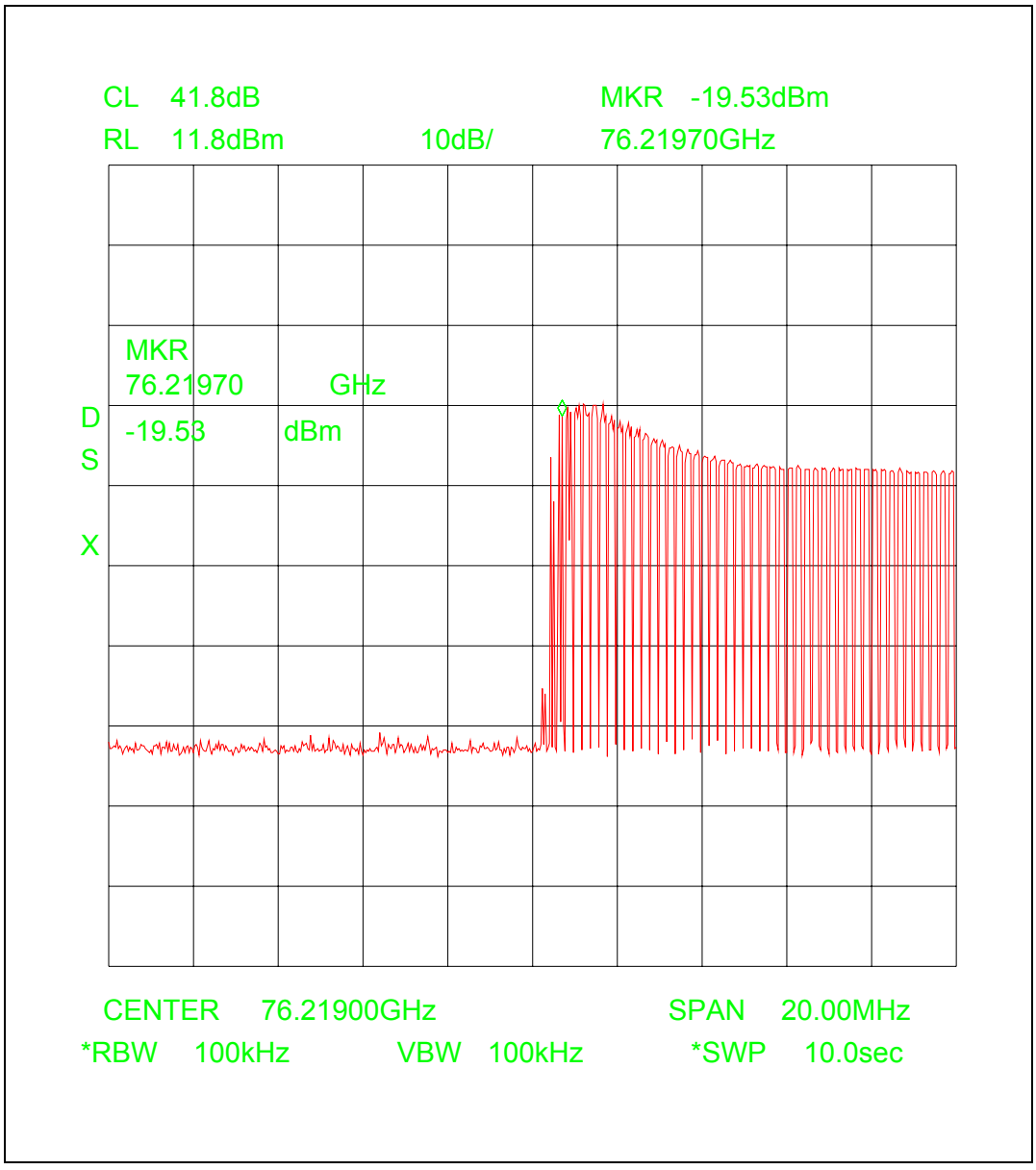
Calculation : Power density = EIRP / Antenna aperture area

pd = -17.7 dBm - 4.55 dB(cm^2)

pd = -22.25 dB(mW/cm^2)

PD = 5.956 $\mu W/cm^2$

Plot 10



Measurement distance d = 3.0 m

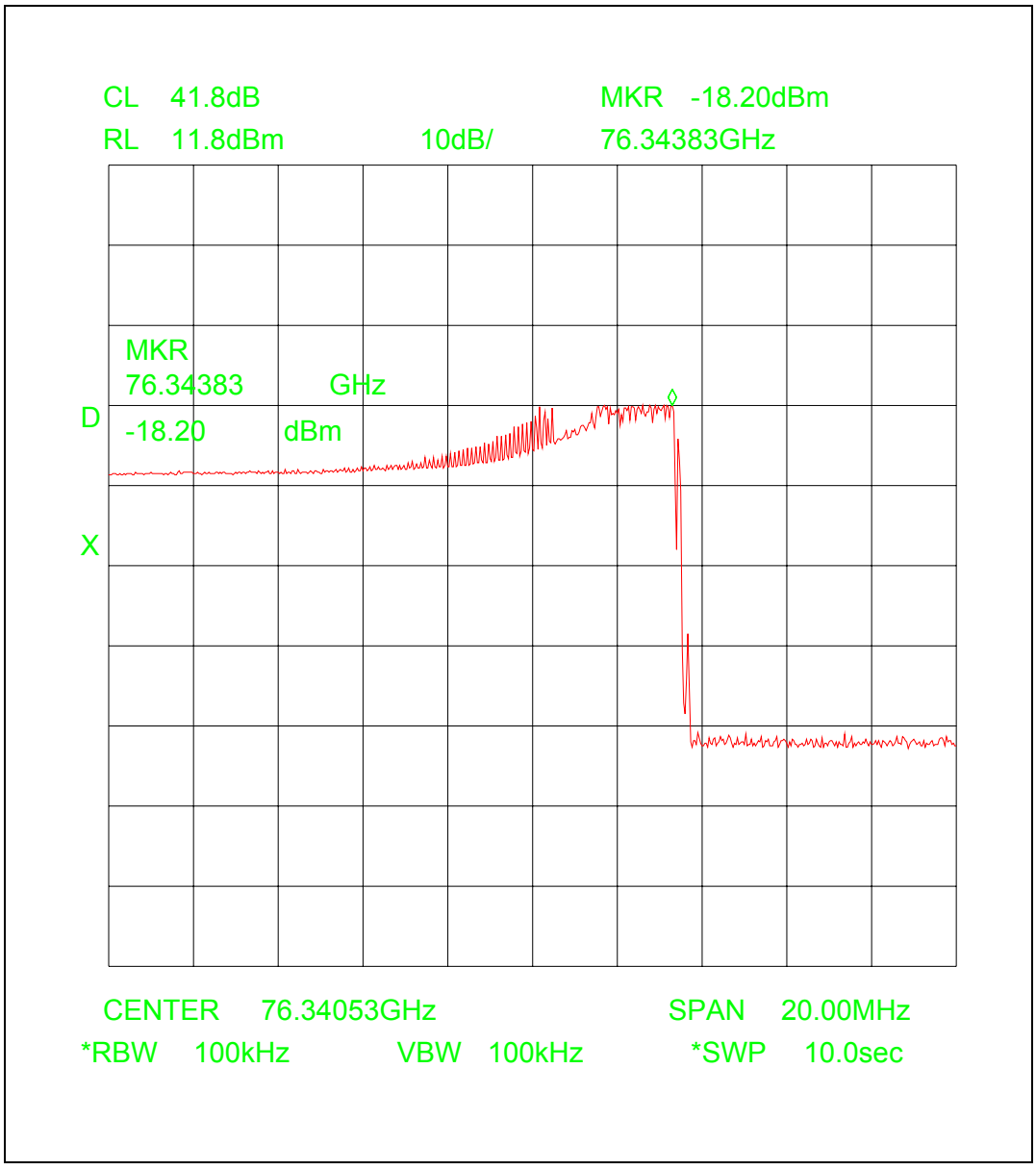
Calculation : Power density = EIRP / Antenna aperture area

pd = -19.5 dBm - 4.55 dB(cm^2)

pd = -24.05 dB(mW/cm^2)

PD = 3.935 $\mu W/cm^2$

Plot 11



Measurement distance d = 3.0 m

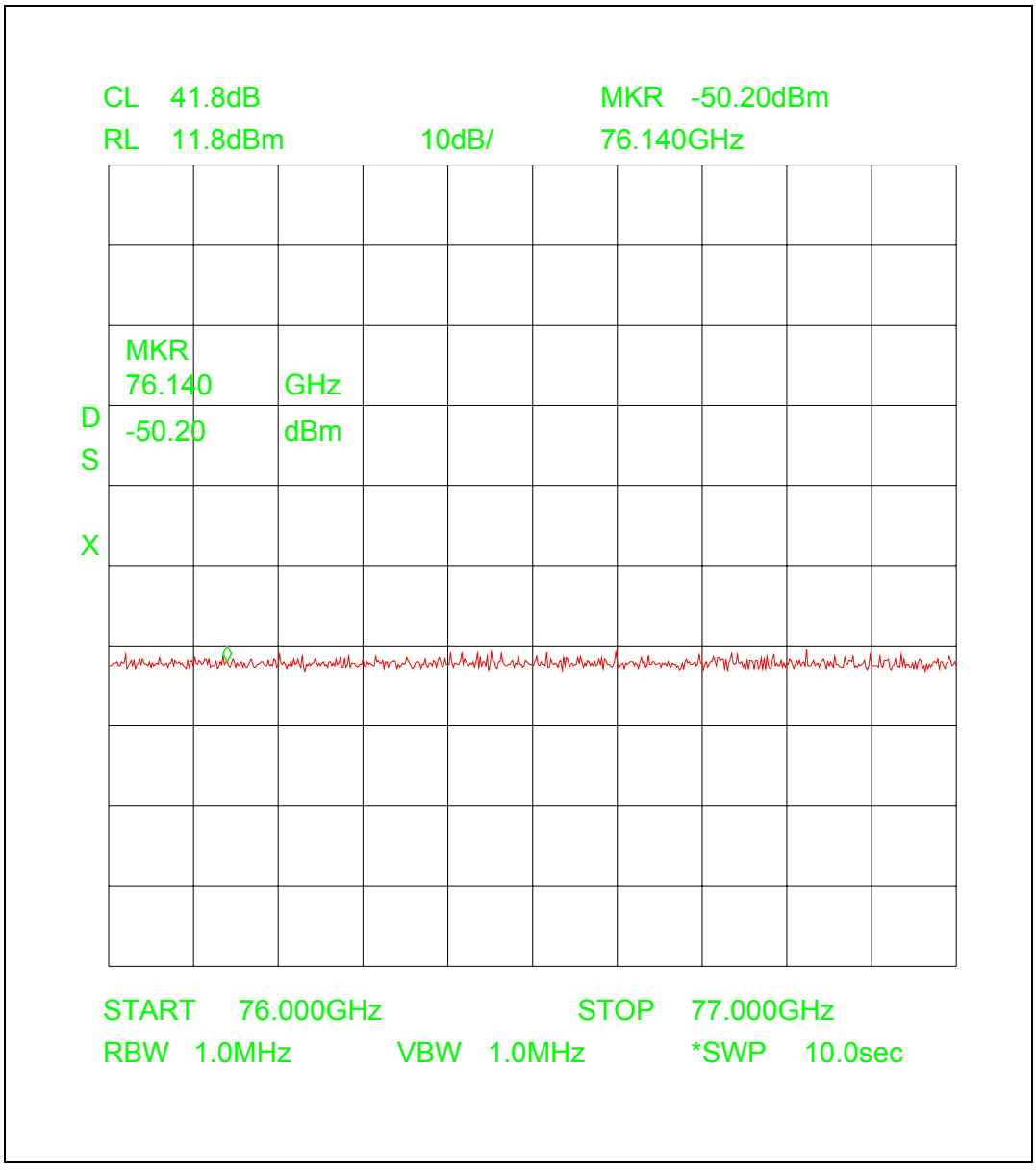
Calculation : Power density = EIRP / Antenna aperture area

pd = -18.2 dBm - 4.55 dB(cm^2)

pd = -22.75 dB(mW/cm^2)

PD = 1.778 $\mu W/cm^2$

Plot 12



Measurement distance d = 3.0 m

Calculation : Power density = EIRP / Antenna aperture area

pd = -50.25 dBm - 4.55 dB(cm^2)

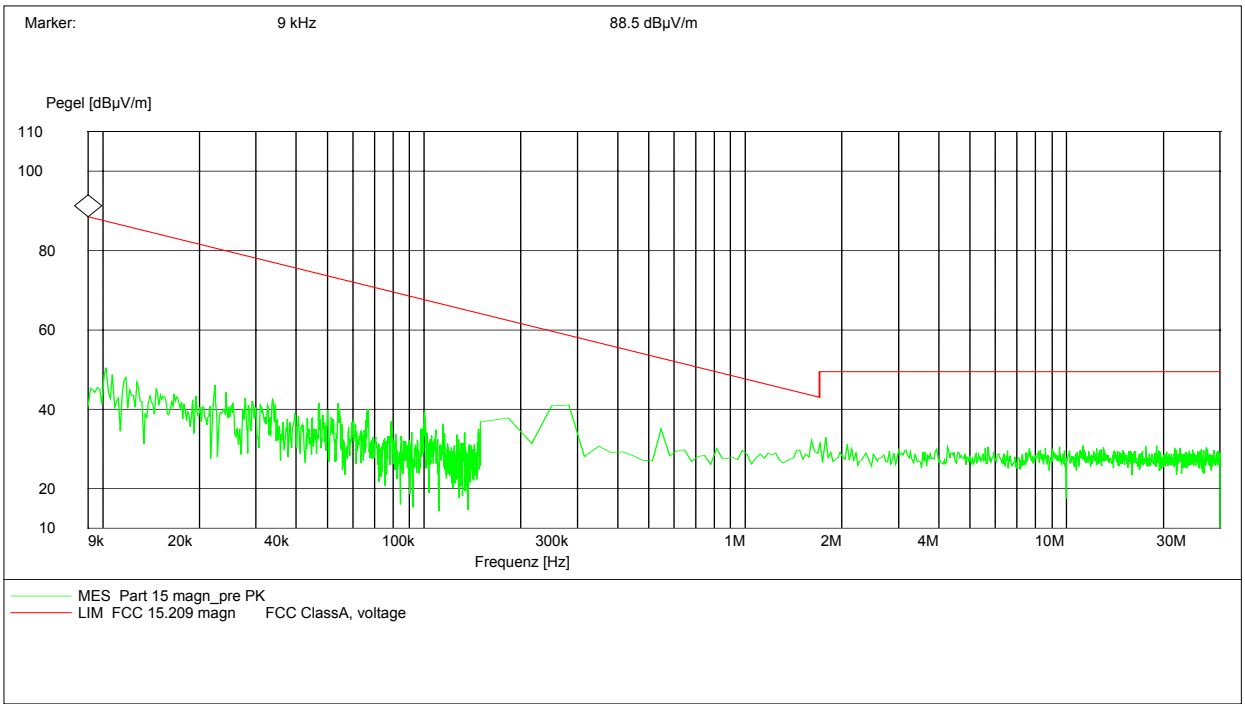
pd = -54.80 dB(mW/cm^2)

PD = 33.113 nW/cm^2

Plot 13

Radio Frequency Devices
Section 15.209

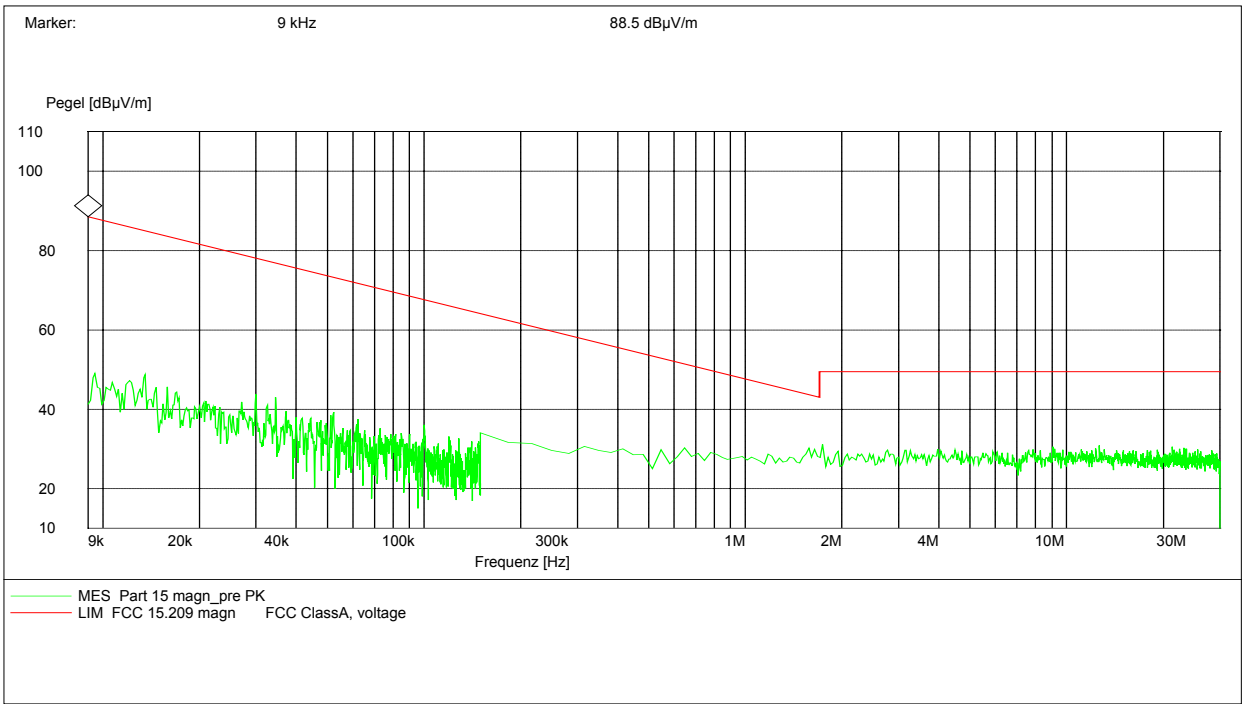
EUT:	Field disturbance sensor DNMWR001
Manufacturer:	DENSO Corporation
RX-Antenna:	R & S HFH Z2 P/N 335.4711.52
Operating Conditions:	TX on and RX on, horizontal plane
Power supply:	U = 13.0 VDC
Test Specification:	FCC 15.209
Start of test:	30.07.2003



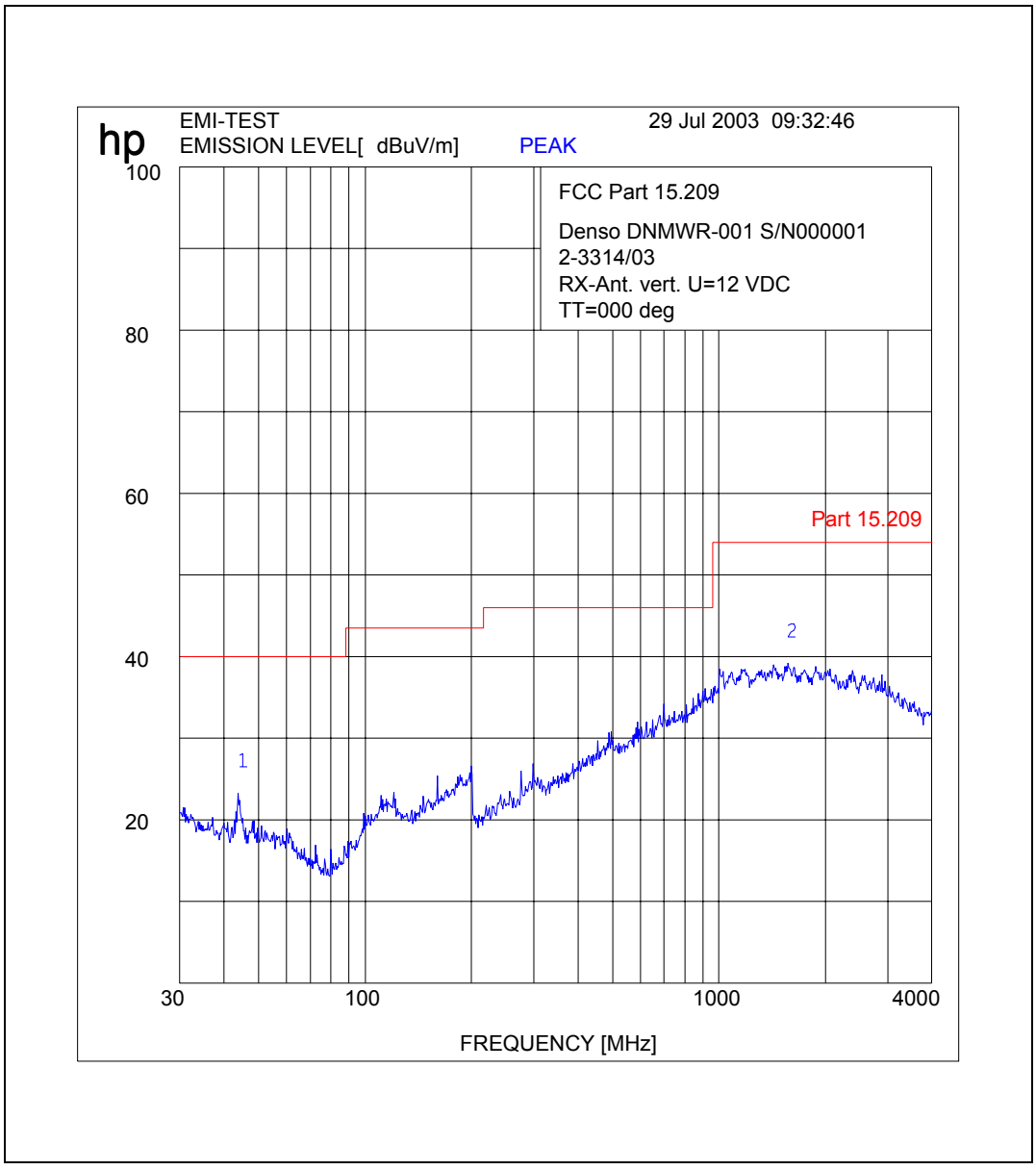
Plot 14

Radio Frequency Devices
Section 15.209

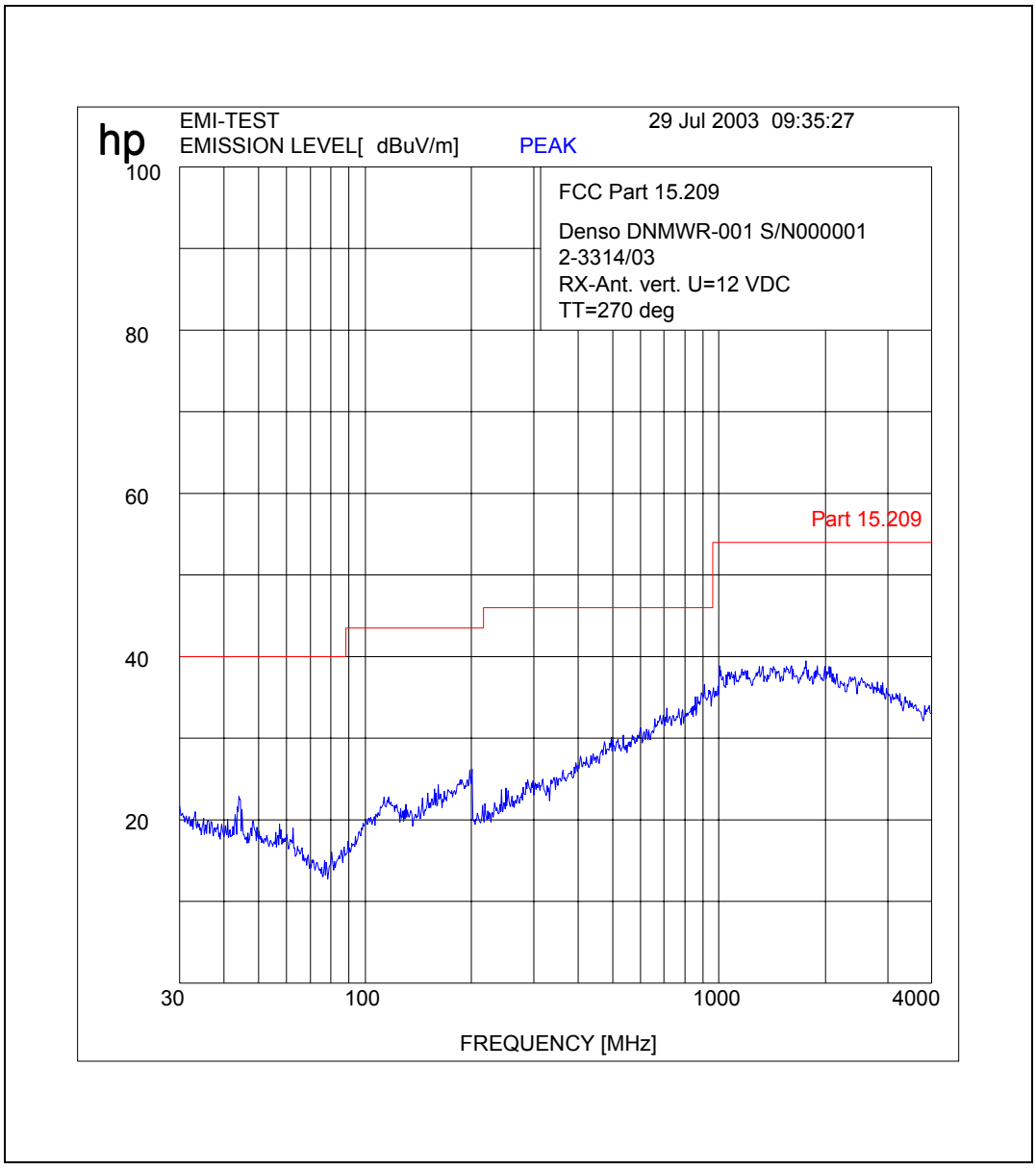
EUT:	Field disturbance sensor DNMWR001
Manufacturer:	DENSO Corporation
RX-Antenna:	R & S HFH Z2 P/N 335.4711.52
Operating Conditions:	TX on and RX on, vertical plane
Power supply:	U = 13.0 VDC
Test Specification:	FCC 15.209
Start of test:	30.07.2003



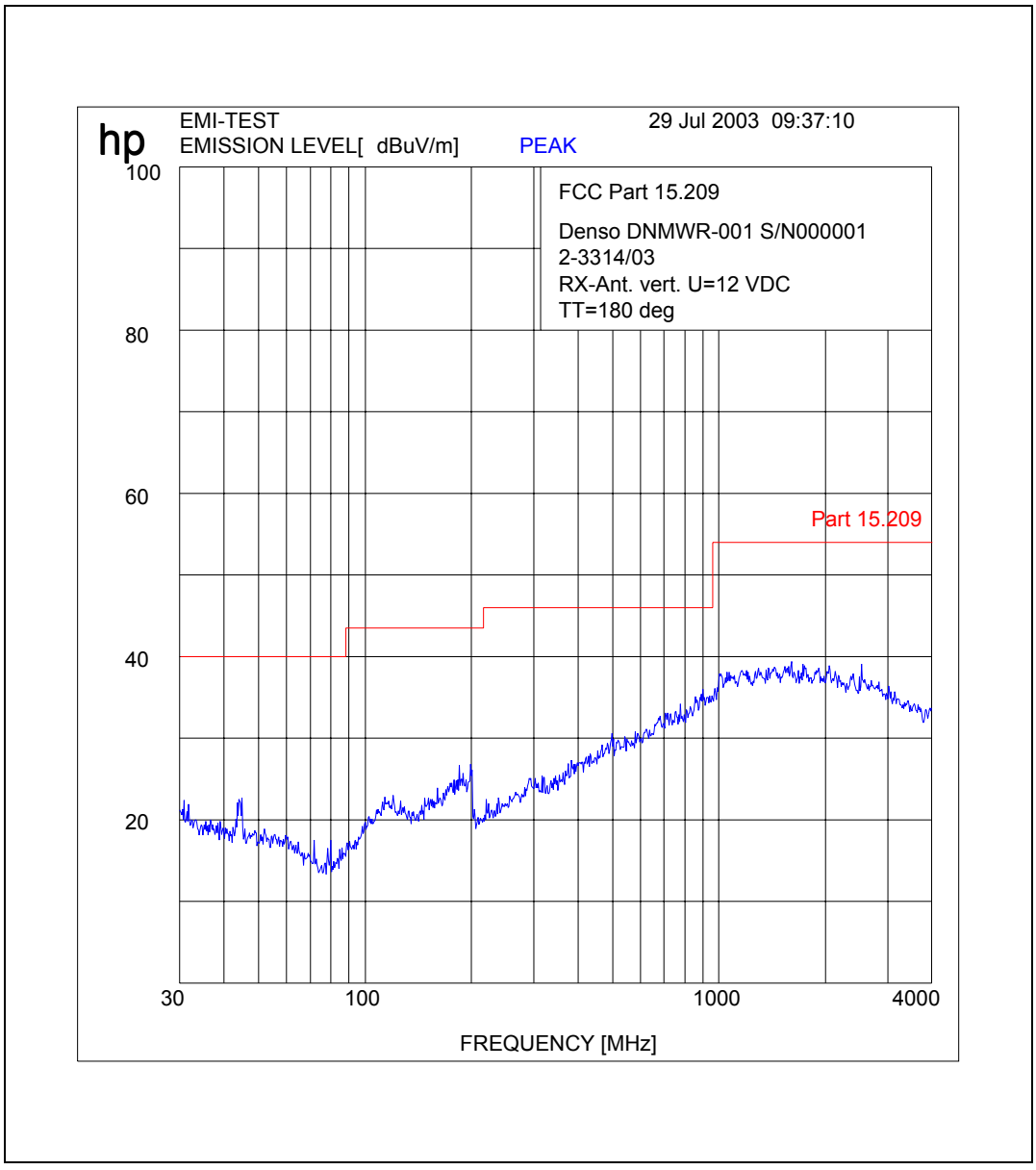
Plot 15


hp
EMI-TEST
29 Jul 2003 09:32:46
EMISSION LEVEL[dBuV/m]
PEAK
FCC Part 15.209
Denso DNMWR-001 S/N000001
2-3314/03
RX-Ant. vert. U=12 VDC
TT=000 deg
Part 15.209
100
80
60
40
20
30
100
1000
4000
FREQUENCY [MHz]
1
2

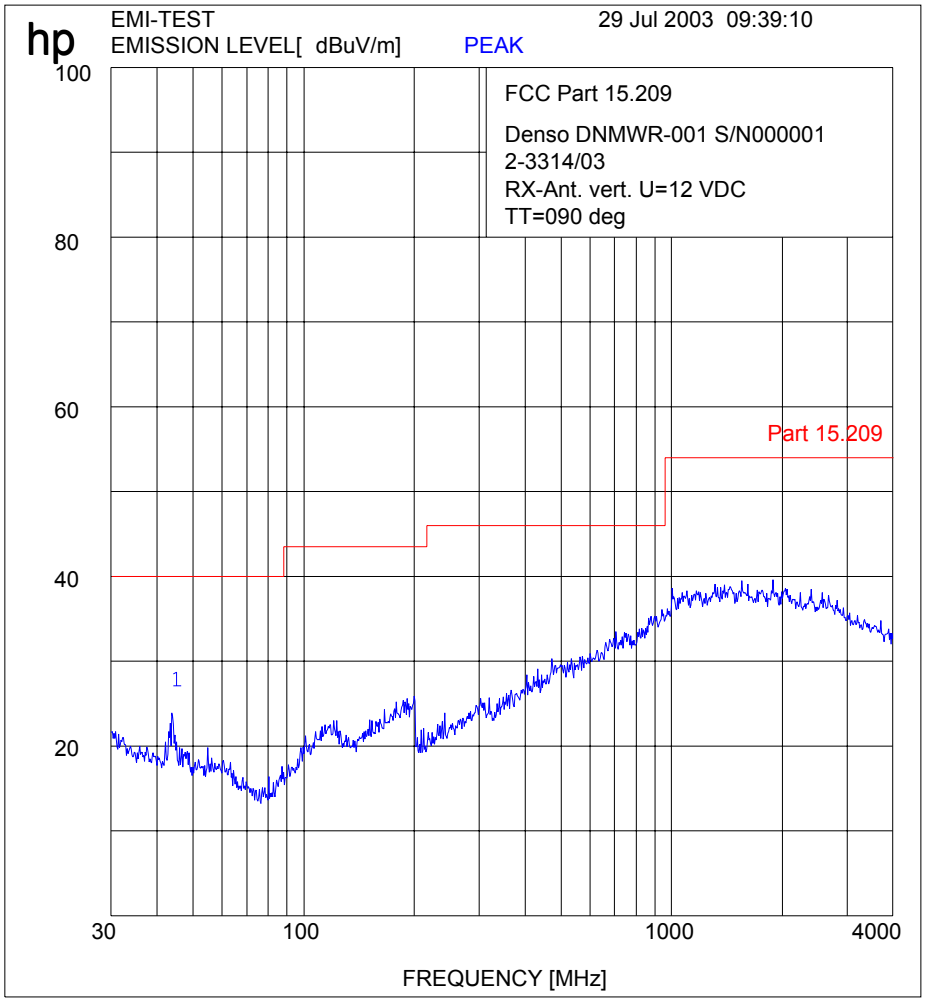
Plot 16


hp
EMI-TEST
29 Jul 2003 09:35:27
EMISSION LEVEL[dBuV/m]
PEAK
FCC Part 15.209
Denso DNMWR-001 S/N000001
2-3314/03
RX-Ant. vert. U=12 VDC
TT=270 deg
Part 15.209
100
80
60
40
20
30
100
1000
4000
FREQUENCY [MHz]

Plot 17


hp
EMI-TEST
29 Jul 2003 09:37:10
EMISSION LEVEL[dBuV/m]
PEAK
FCC Part 15.209
Denso DNMWR-001 S/N000001
2-3314/03
RX-Ant. vert. U=12 VDC
TT=180 deg
Part 15.209
100
80
60
40
20
30
100
1000
4000
FREQUENCY [MHz]

Plot 18



Measurement distance d = 1.0 m

Calculation : Field strength = Analyser reading + Antenna factor + distance corr. + cable loss

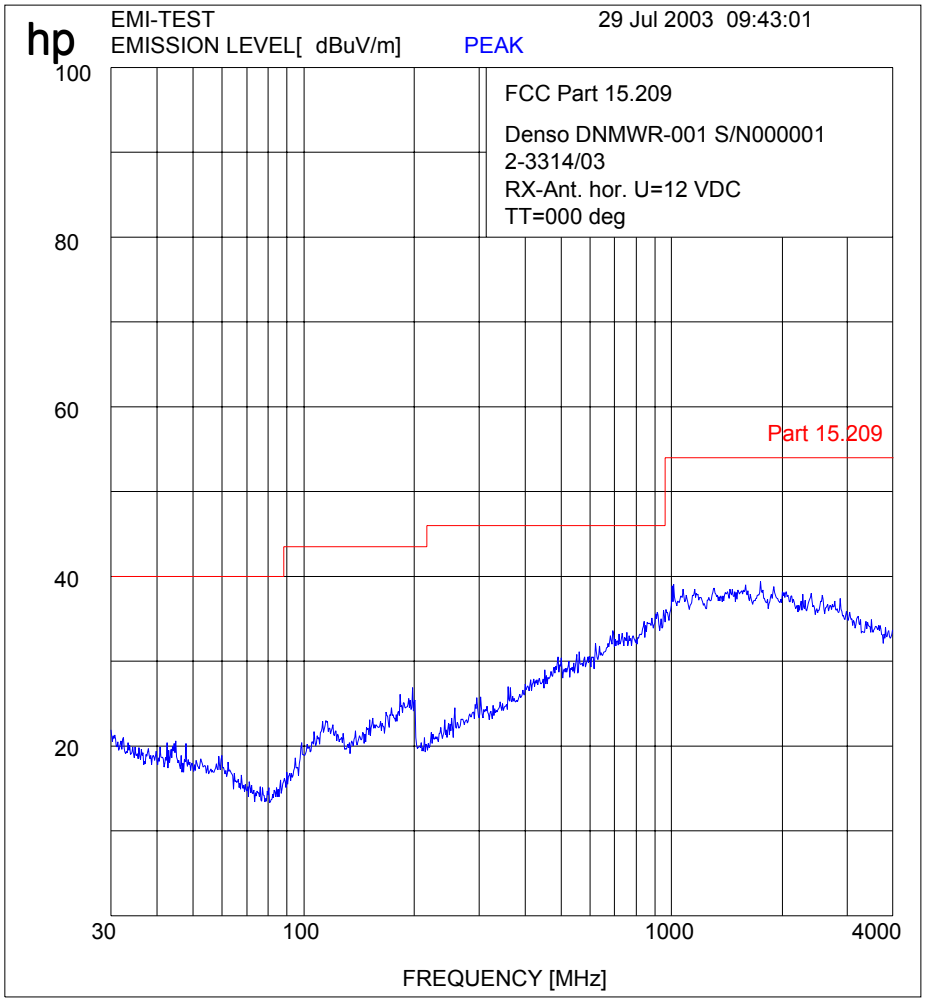
e = -28.17 dBmV + 28.5 dB(1/m) + (- 9.54 dB) + 1.5 dB

e = -10.41 dB(mV/m)

E = 0.30165 mV/m

E = 316.5 µV/m

Plot 19



Measurement distance d = 0.5 m

Calculation : Field strength = Analyser reading + Antenna factor + distance corr. + cable loss

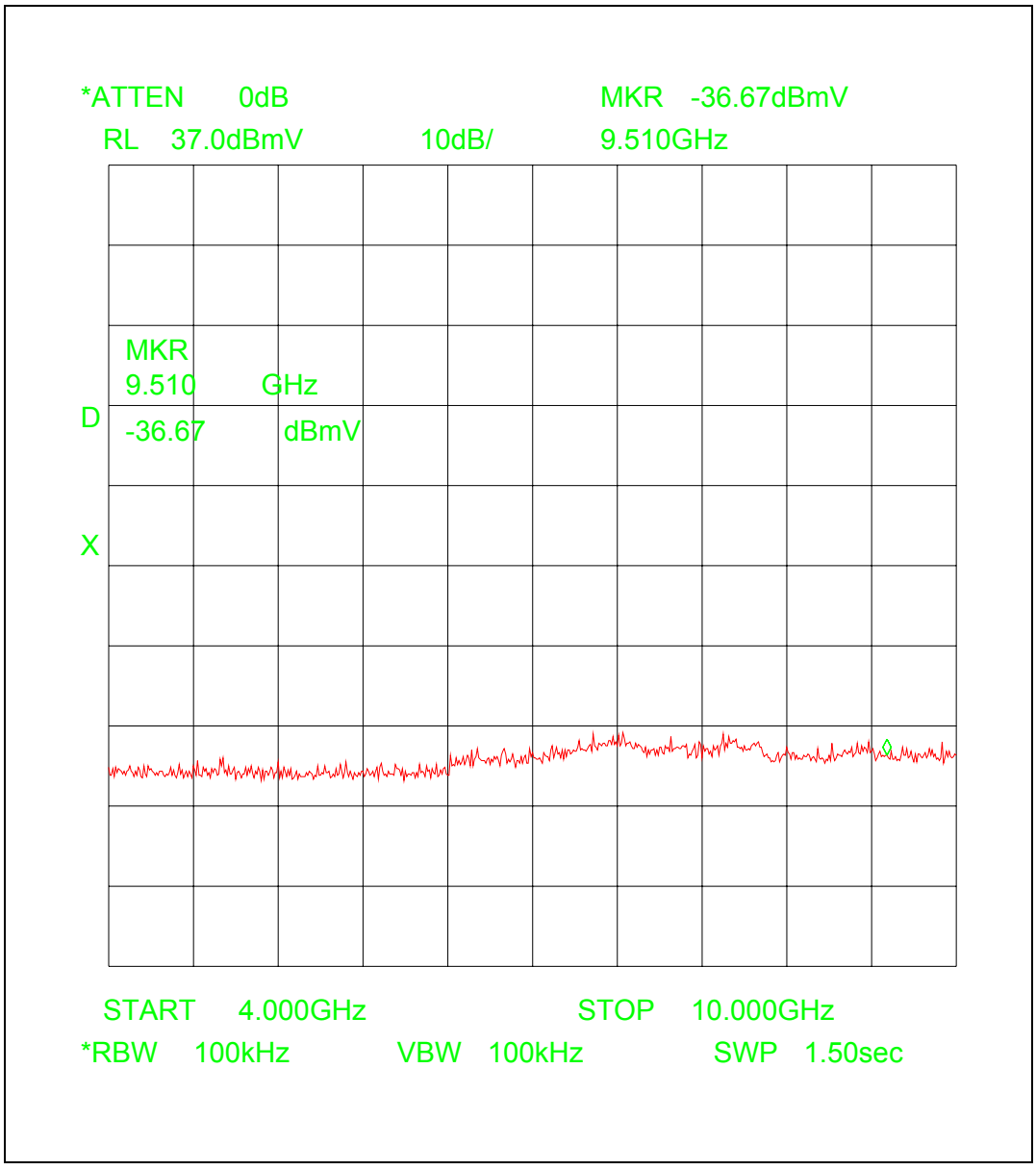
e = -33.33 dBmV + 35.2 dB(1/m) + (- 15.56 dB) + 1.8 dB

e = -11.89 dB(mV/m)

E = 0.2544 mV/m

E = 254.4 µV/m

Plot 20



Measurement distance d = 0.5 m

Calculation : Field strength = Analyser reading + Antenna factor + distance corr. + cable loss

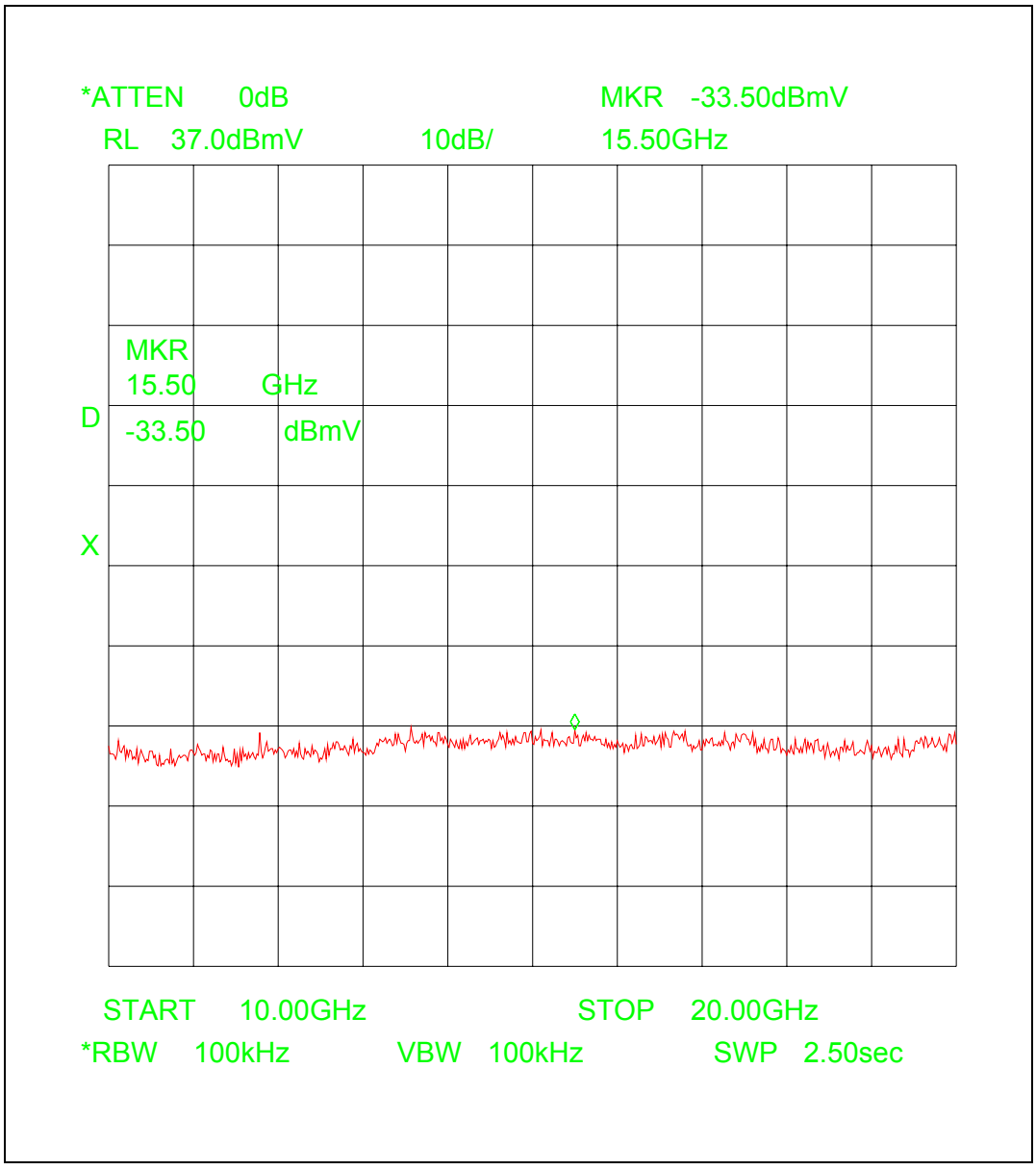
e = -36.67 dBmV + 38.6 dB(1/m) + (- 15.56 dB) + 1.8 dB

e = -11.83 dB(mV/m)

E = 0.256 mV/m

E = 256.15 µV/m

Plot 21



Measurement distance d = 0.5 m

Calculation : Field strength = Analyser reading + Antenna factor + distance corr. + cable loss

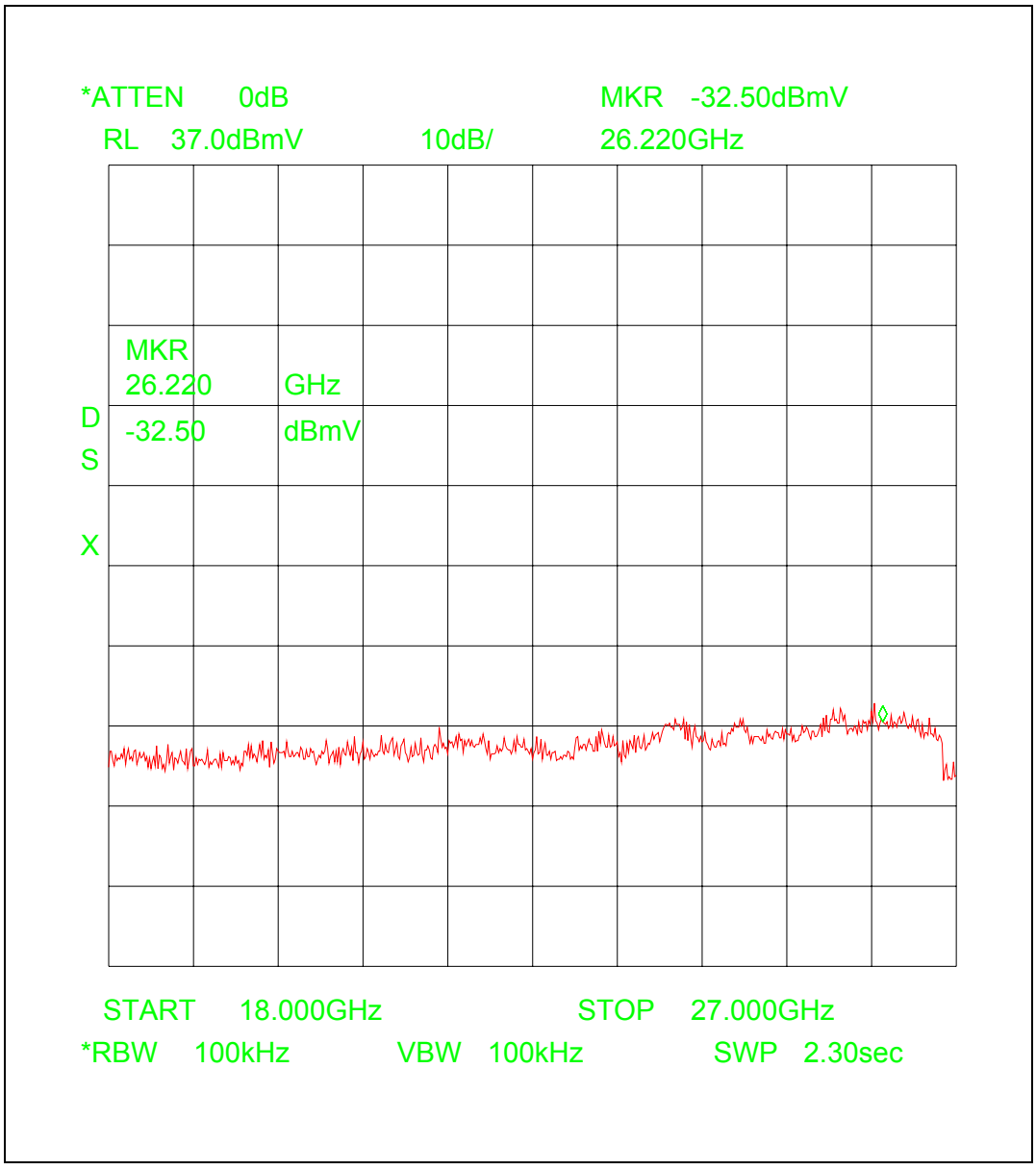
e = -33.5 dBm + 38.0 dB(1/m) + (- 15.56 dB) + 2.0 dB

e = -9.06 dB(mV/m)

E = 0.352 mV/m

E = 352.37 µV/m

Plot 22



Measurement distance d = 0.25 m

Calculation : Field strength = Analyser reading + Antenna factor + distance corr. + cable loss

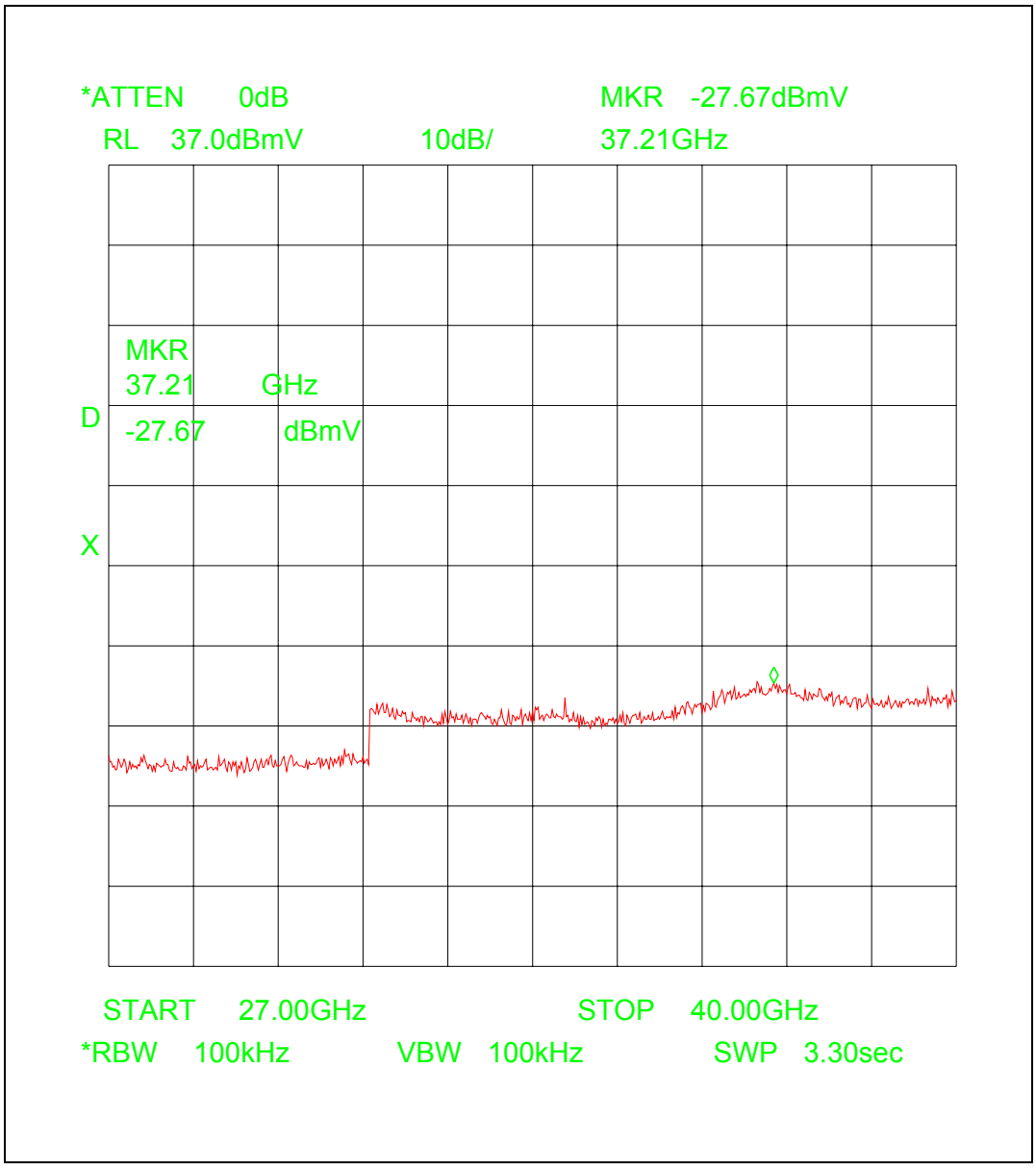
e = -32.5 dBmV + 40.4 dB(1/m) + (- 21.56 dB) + 2.8 dB

e = -10.86 dB(mV/m)

E = 0.286 mV/m

E = 286.41 µV/m

Plot 23



Measurement distance d = 0.25 m

Calculation : Field strength = Analyser reading + Antenna factor + distance corr. + cable loss

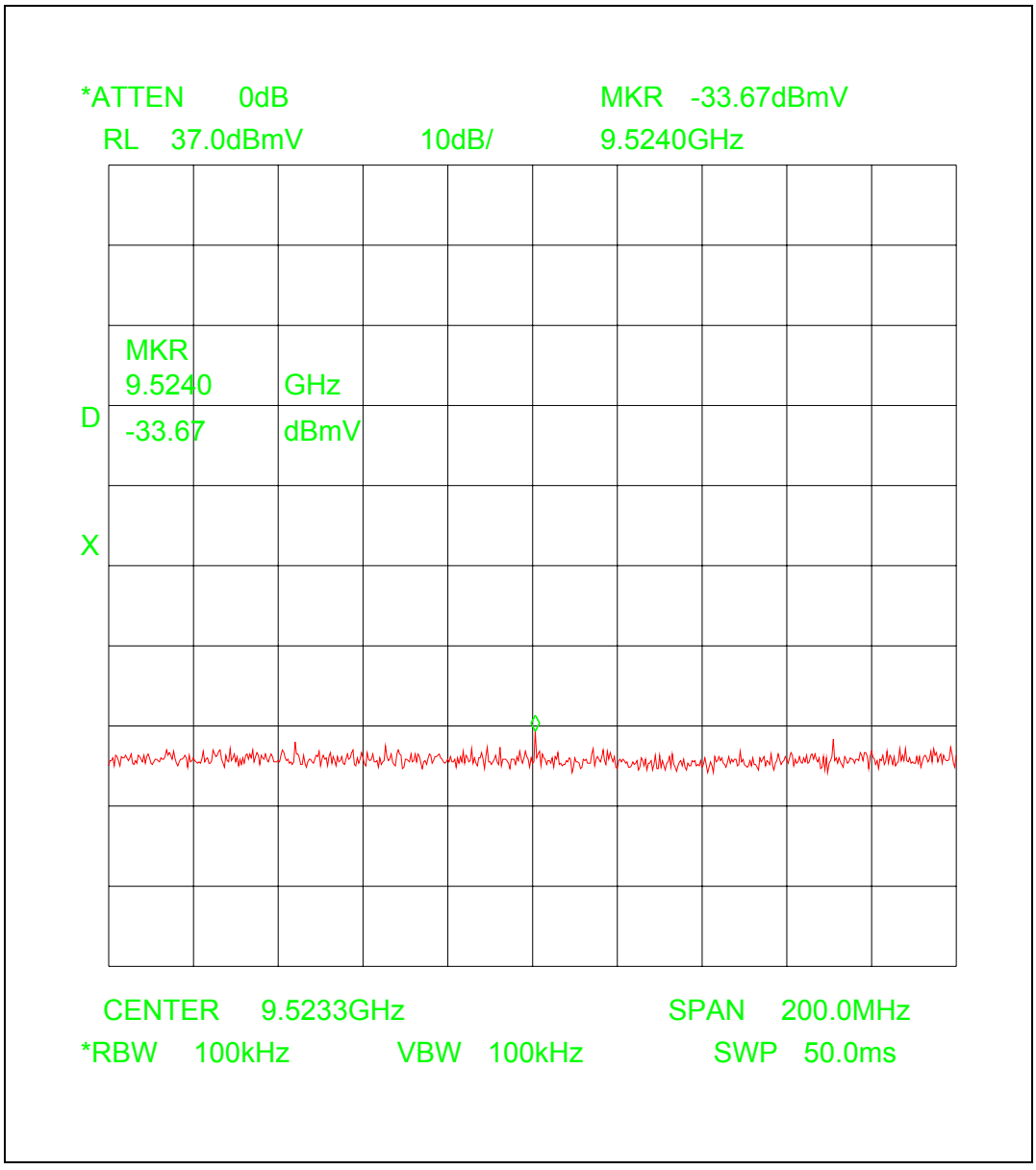
e = -27.67 dBm + 40.8 dB(1/m) + (- 21.58 dB) + 2.0 dB

e = -6.25 dB(mV/m)

E = 0.475 mV/m

E = 475.88 µV/m

Plot 24



Measurement distance d = 0.25 m

Calculation : Field strength = Analyser reading + Antenna factor + distance corr. + cable loss

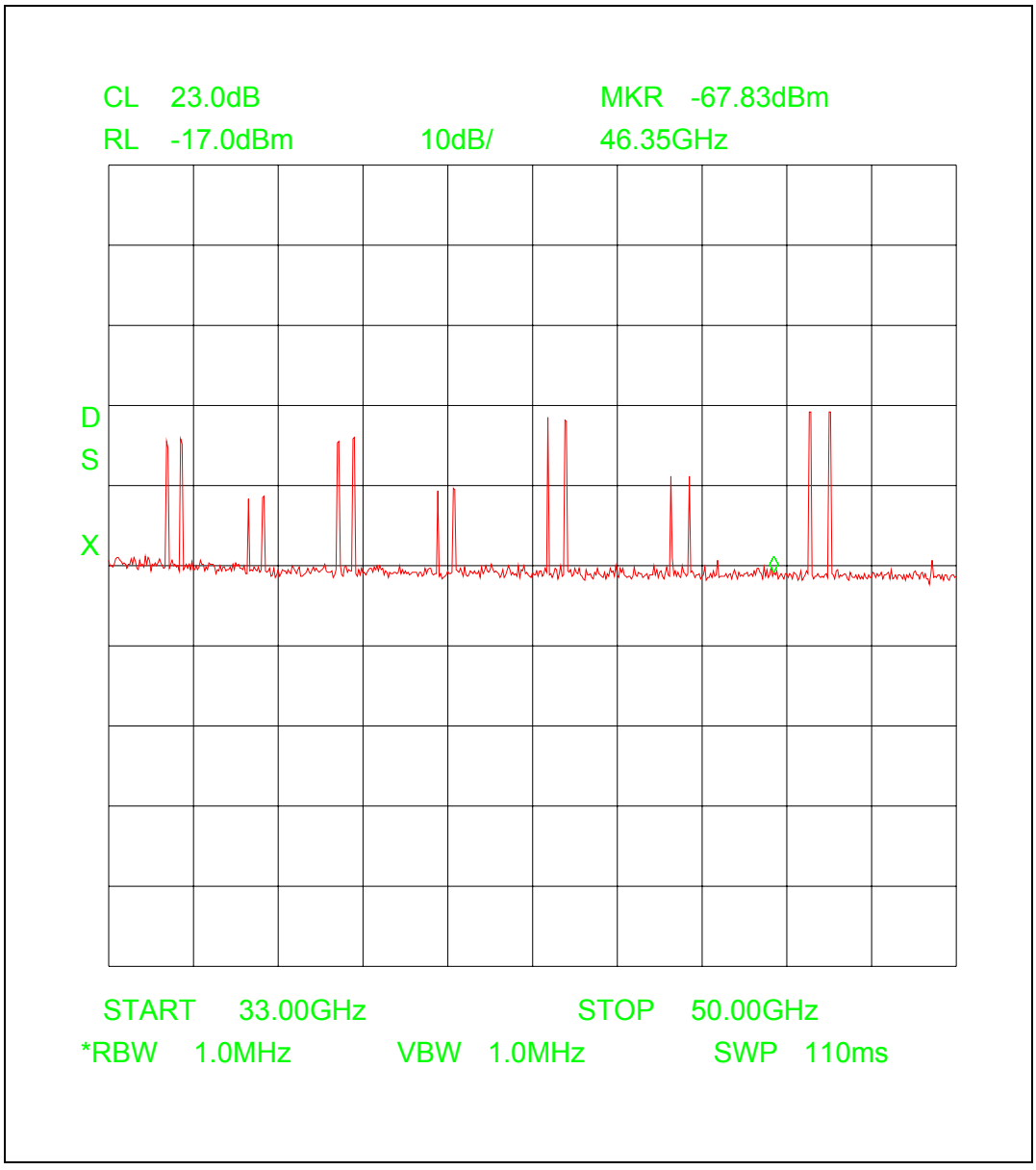
e = -33.67 dBm + 40.4 dB(1/m) + (- 21.58 dB) + 2.0 dB

e = -12.85 dB(mV/m)

E = 0.227 mV/m

E = 227.77 µV/m

Plot 25



Measurement distance d = 3.0 m

Calculation : Power density = EIRP (Noise) / Ant. aperture area

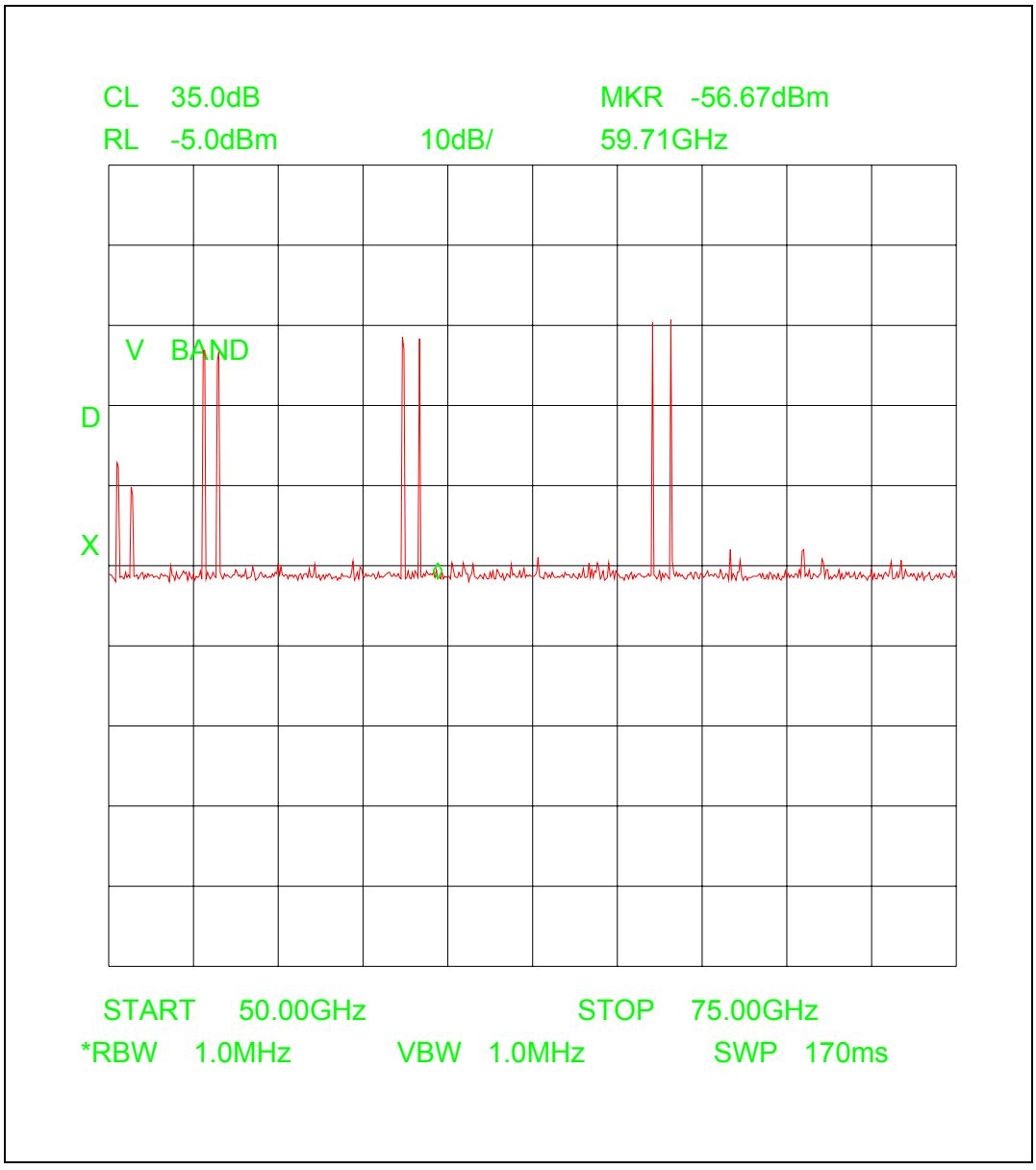
pd = -67.83 dBm - 10.64 dB(cm^2)

pd = -78.47 dB (mW/cm^2)

PD = 14.22 pW/cm^2

Remarks: Spurious frequencies e.g. 34.16 GHz and 36.09 GHz are produced by the external mixer. They are image frequency responses, and can be identified by calling up signal identifier program. Harmonics of f(LO) = 9.523 GHz are not traceable

Plot 26



Measurement distance d = 3.0 m

Calculation : Power density = EIRP (Noise) / Ant. aperture area

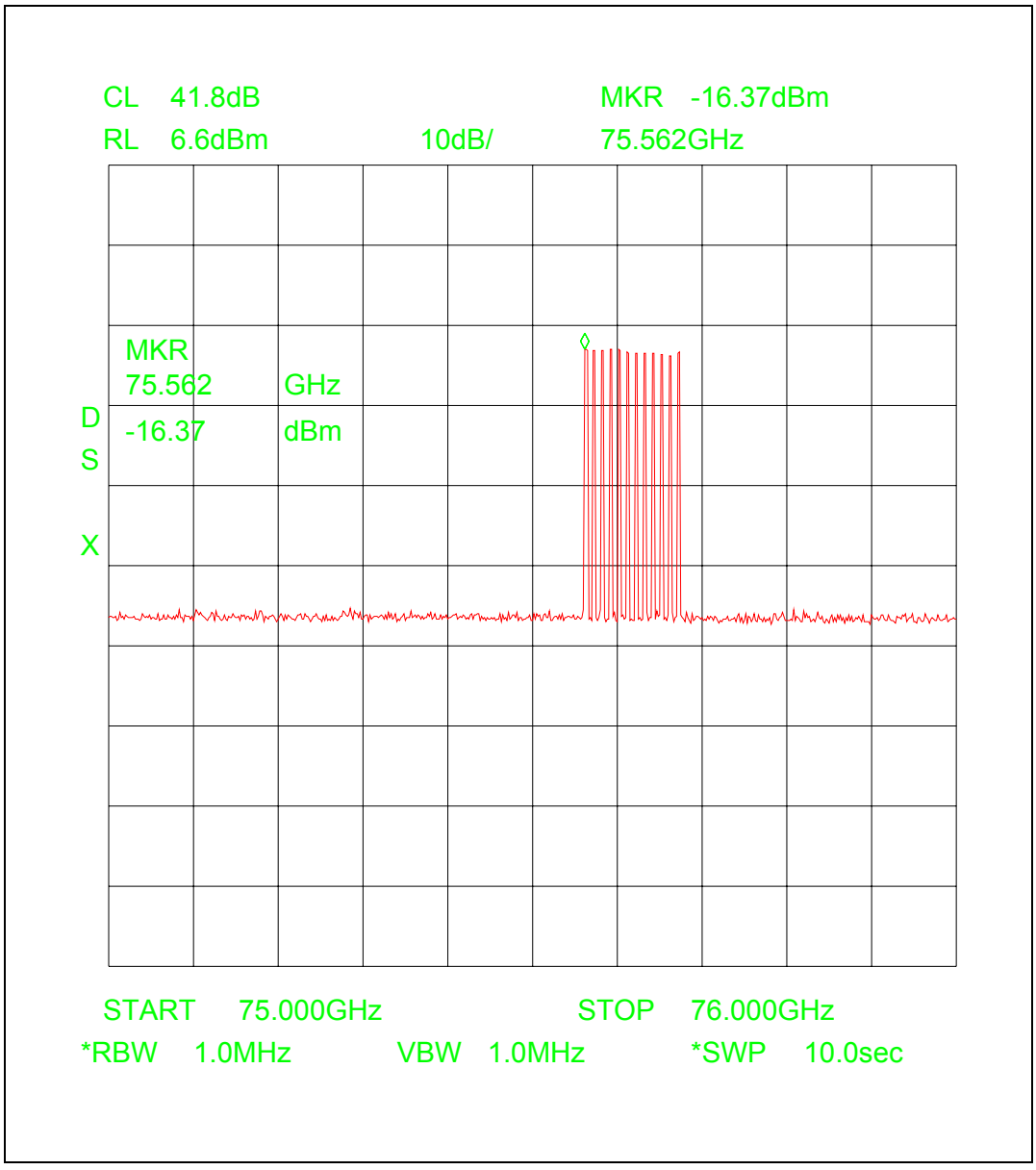
pd = -56.67 dBm - 8.98 dB(cm^2)

pd = -65.65 dB(mW/cm^2)

PD = 272.27 pW/cm^2

Remark: Spurious frequencies e.g. 50.25 GHz and 53.55 GHz are produced by the external mixer They are image frequency responses, and can be identified by calling up signal identifier program. Harmonics of f(LO) = 9.523 GHz are not traceable

Plot 27



Measurement distance d = 0.25 m

Calculation : Power density = EIRP (Noise) / Ant. aperture area x dist. corr.

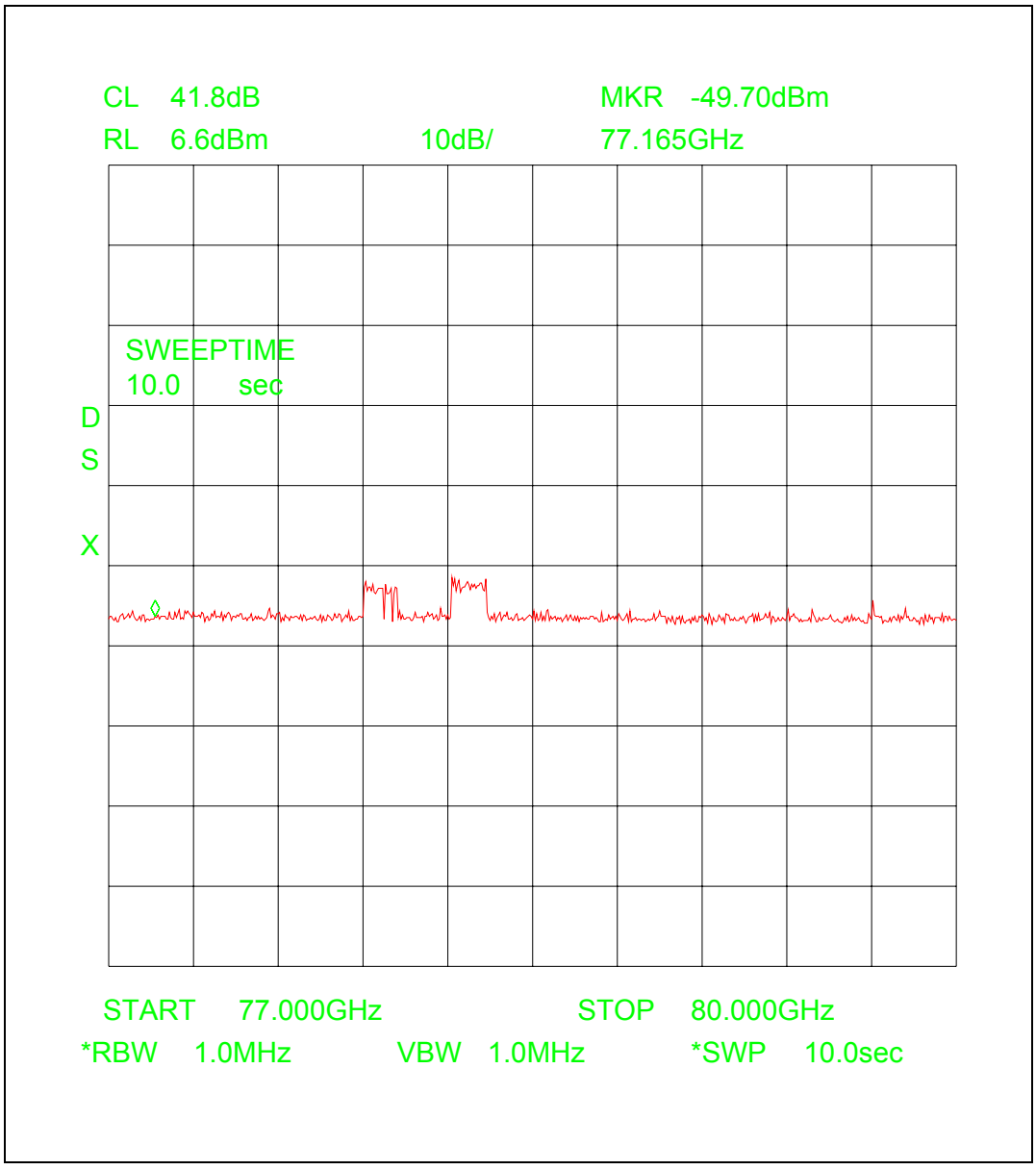
pd = -50.8 dBm - 4.55 dB(cm^2) + (-21.58 dB)

pd = -76.93 dB(mW/cm^2)

PD = 20.27 pW/cm^2

Remark: Spurious frequencies 75.562 to 75.684 GHz are produced by the external mixer
They are image frequency responses, and can be identified by calling up signal identifier program.
Harmonics of f(LO) = 9.523 GHz are not traceable

Plot 28



Measurement distance d = 0.25 m

Calculation : Power density = EIRP (Noise) / Ant. aperture area x dist. corr.

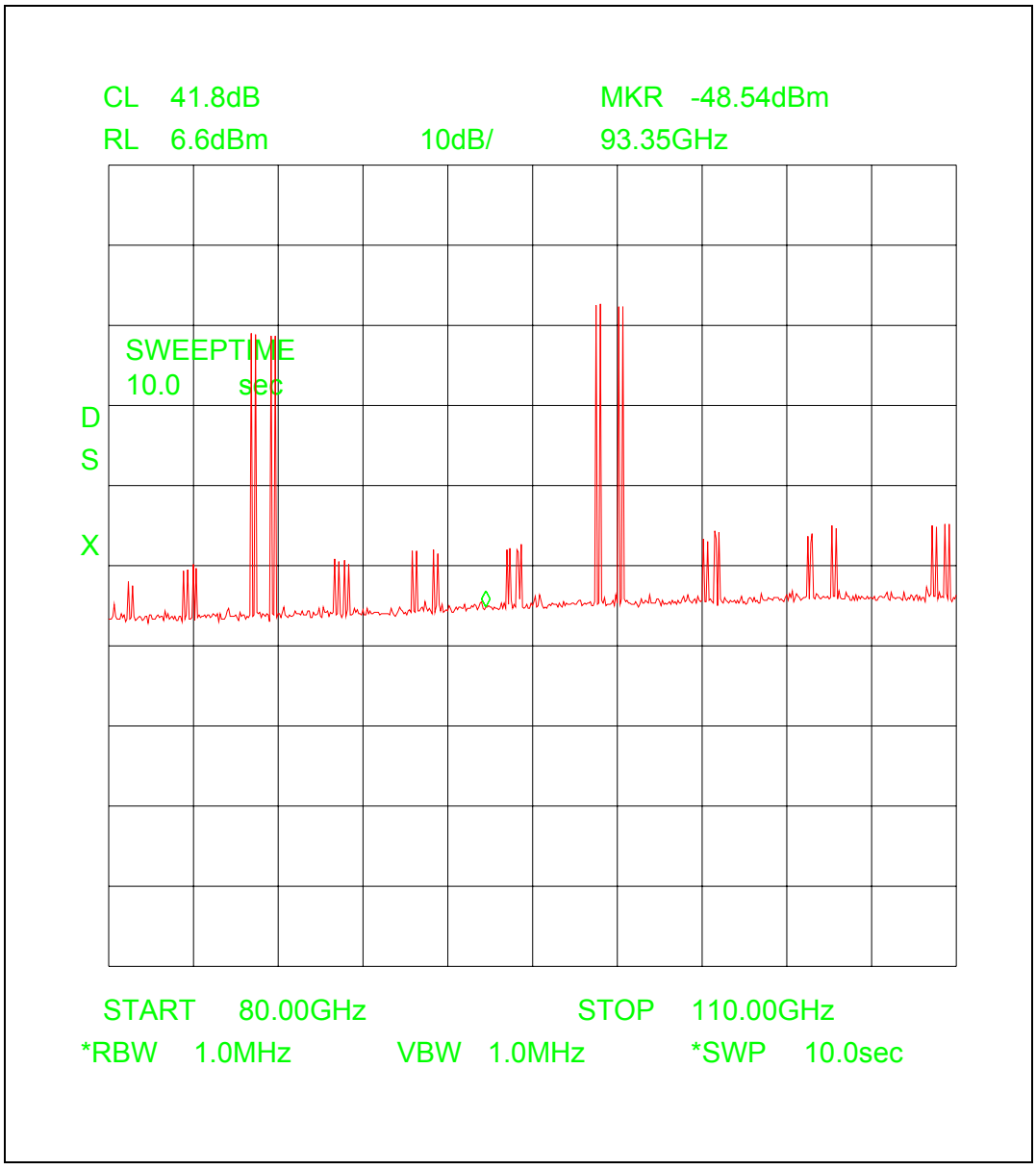
pd = -49.7 dBm - 4.55 dB(cm^2) + (-21.58 dB)

pd = -75.83 dB(mW/cm^2)

PD = 26.12 pW/cm^2

Remark: Spurious frequencies e.g. 78.16 GHz and 78.55 GHz are produced by the external mixer. They are image frequency responses, and can be identified by calling up signal identifier program. Harmonics of f(LO) = 9.523 GHz are not traceable

Plot 29



Measurement distance d = 0.25 m Analyser reading: -4.25 dBmV = -13.08 dBm

Calculation : Power density = EIRP (Noise) / Ant. aperture area x dist. corr.

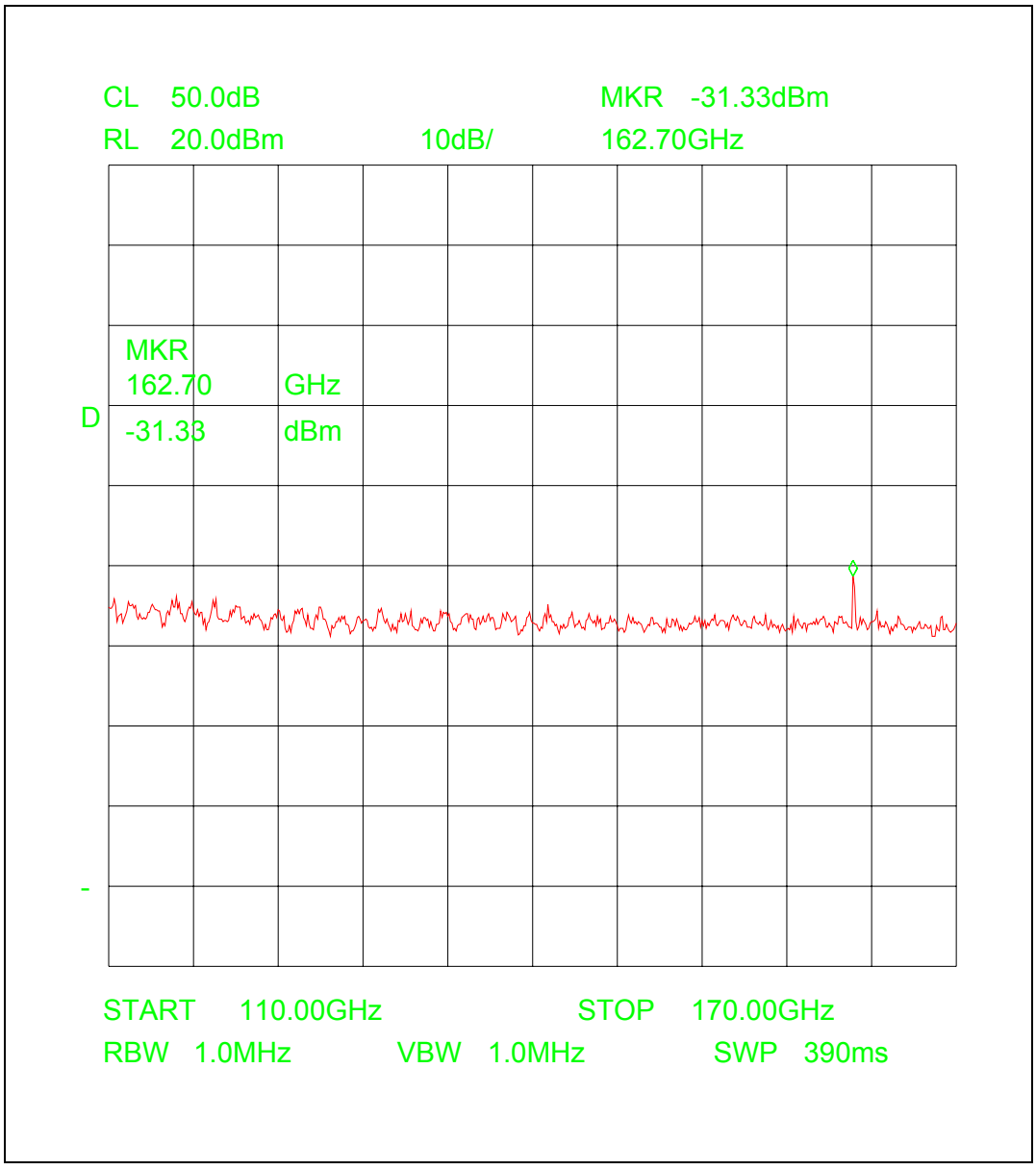
pd = -48.54 dBm - 4.55 dB(cm^2) + (-21.58 dB)

pd = -74.67 dB(mW/cm^2)

PD = 34.11 pW/cm^2

Remark: Spurious frequencies e.g. 85.05 GHz and 90.75GHz are produced by the external mixer. They are image frequency responses, and can be identified by calling up signal identifier program. Harmonics of f(LO) = 9.523 GHz are not traceable

Plot 30



Measurement distance d = 0.25 m

Calculation : Power density = EIRP (Noise) / Ant. aperture area x dist. corr.

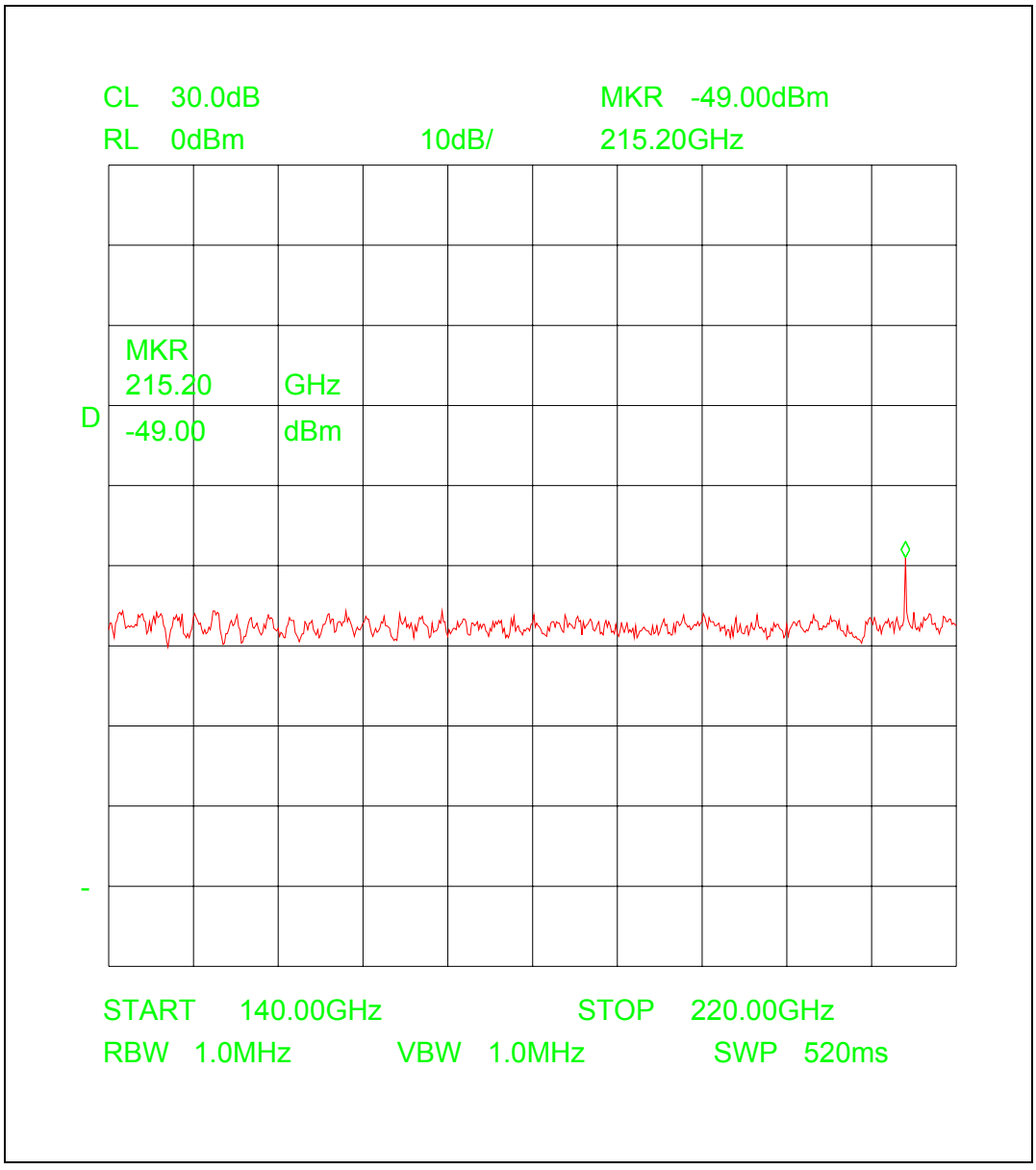
pd = -41.7 dBm - 0.13 dB(cm^2) + (-21.58 dB)

pd = -63.41 dB(mW/cm^2)

PD = 456.03 pW/cm^2

Remark: Spurious frequencies e.g. 162.7 GHz are produced by the external mixer.
They are image frequency responses, and can be identified by calling up signal identifier program.
Harmonics of f(LO) = 9.523 GHz are not traceable

Plot 31



Measurement distance d = 0.25 m

Calculation : Power density = EIRP (Noise) / Ant. aperture area x dist. corr.

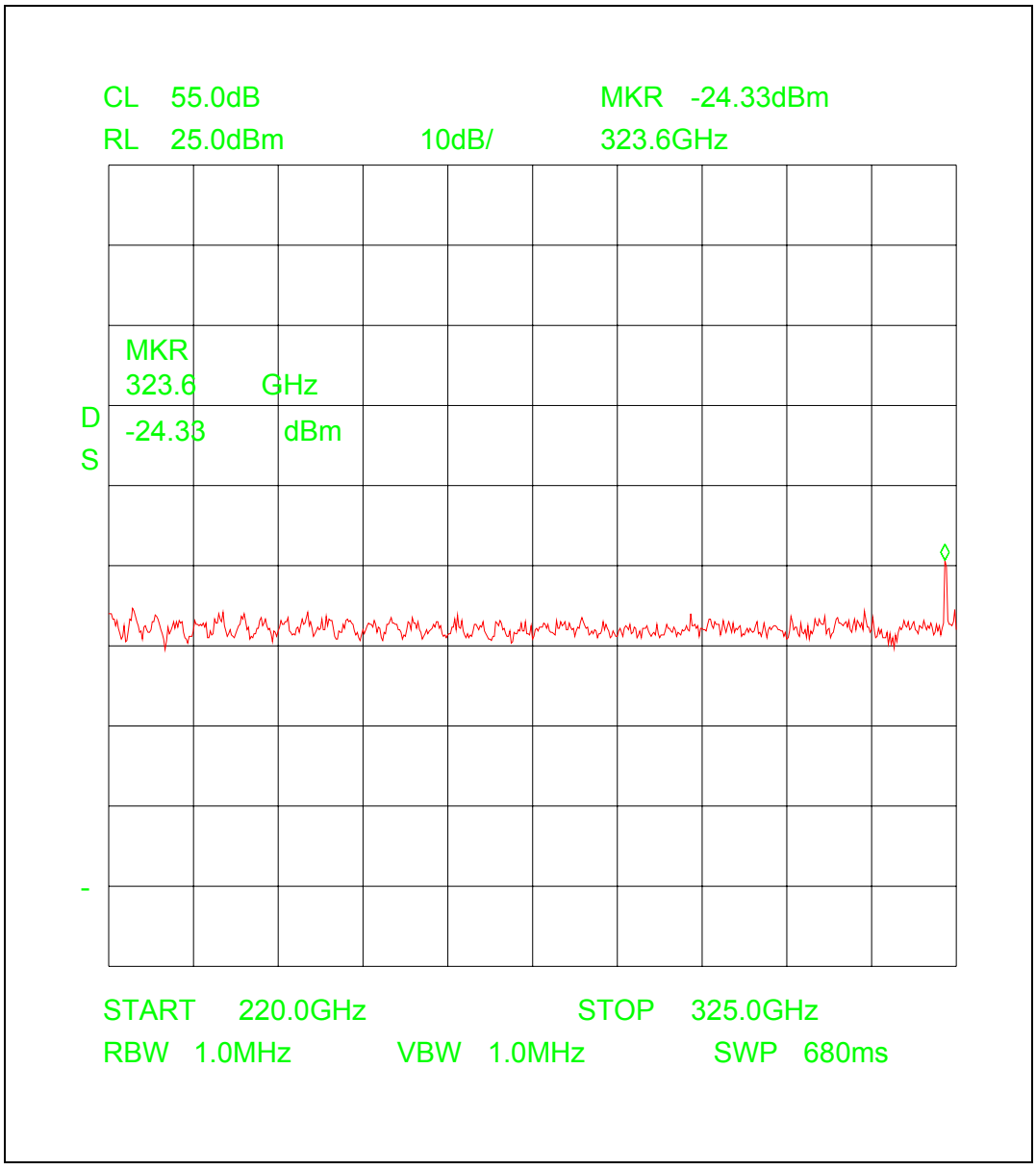
pd = -59.0 dBm - (-0.22 dB(cm^2)) + (-21.58 dB)

pd = -80.36 dB(mW/cm^2)

PD = 9.204 pW/cm^2

Remark: Spurious frequencies e.g. 215.2 GHz are produced by the external mixer.
They are image frequency responses, and can be identified by calling up signal identifier program.
Harmonics of f(LO) = 9.523 GHz are not traceable

Plot 32



Measurement distance d = 0.125 m

Calculation : Power density = EIRP (Noise) / Ant. aperture area x dist. corr.

pd = -33.33 dBm - (-0.22 dB(cm^2)) + (-27.60 dB)

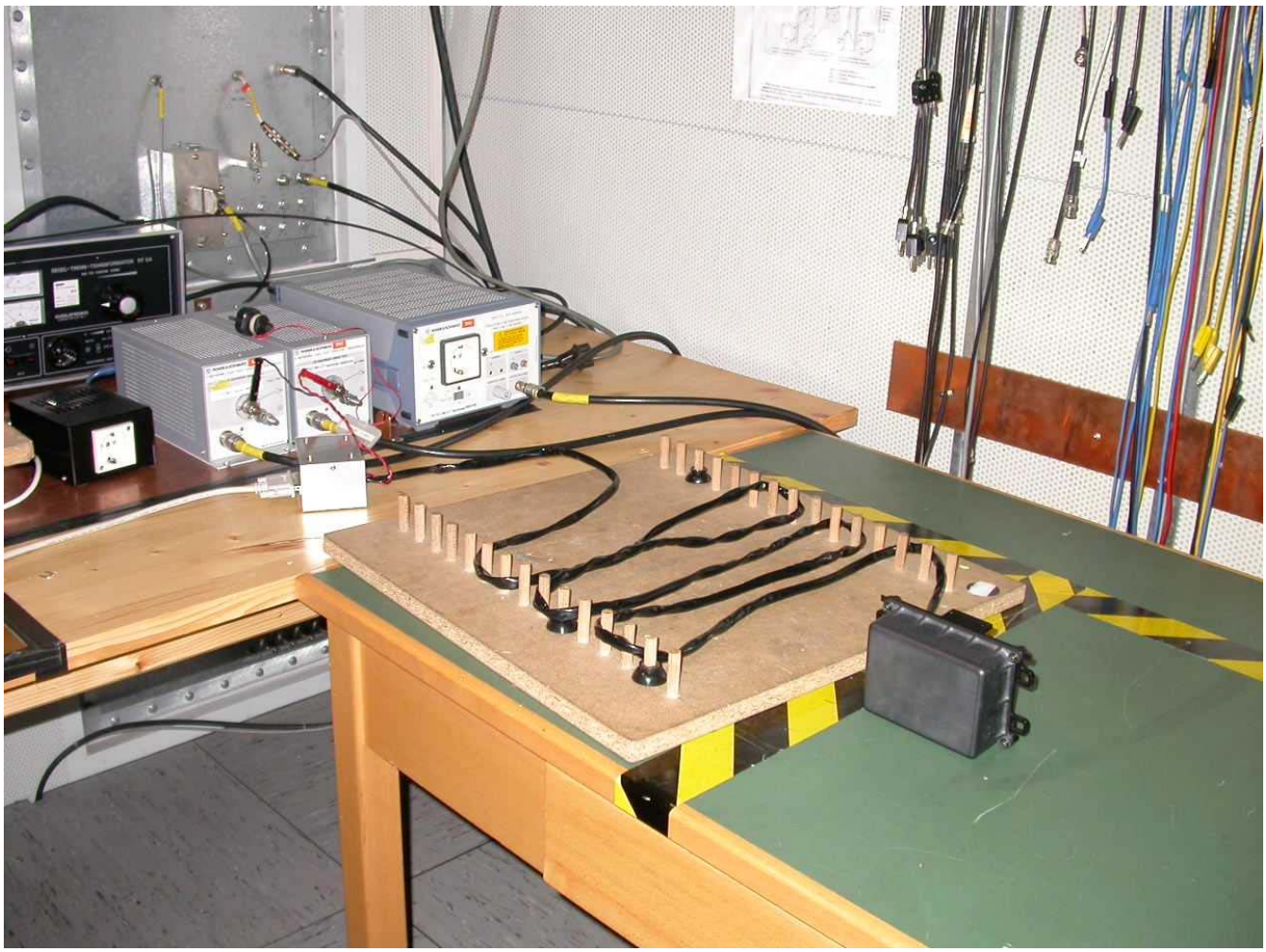
pd = -60.71 dB(mW/cm^2)

PD = 849.18 pW/cm^2

Remark: Spurious frequencies e.g. 323.6 GHz are produced by the external mixer.
They are image frequency responses, and can be identified by calling up signal identifier program.
Harmonics of f(LO) = 9.523 GHz are not traceable

4. Photographs

Photo 1



Spurious radiation measurement in the frequency range 9 kHz to 30 MHz

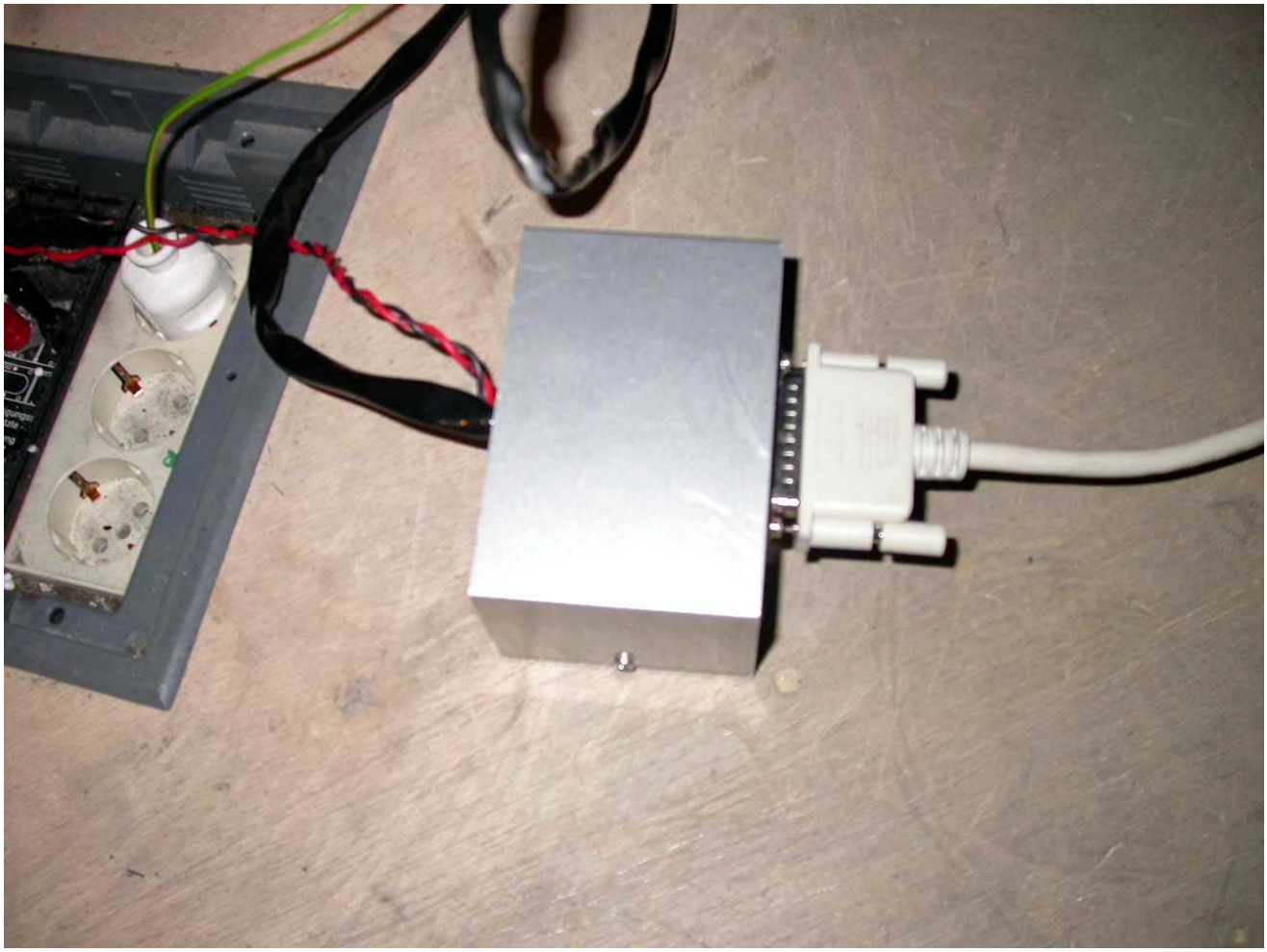
Photo 2

Measurements under extreme temperature conditions

Photo 3

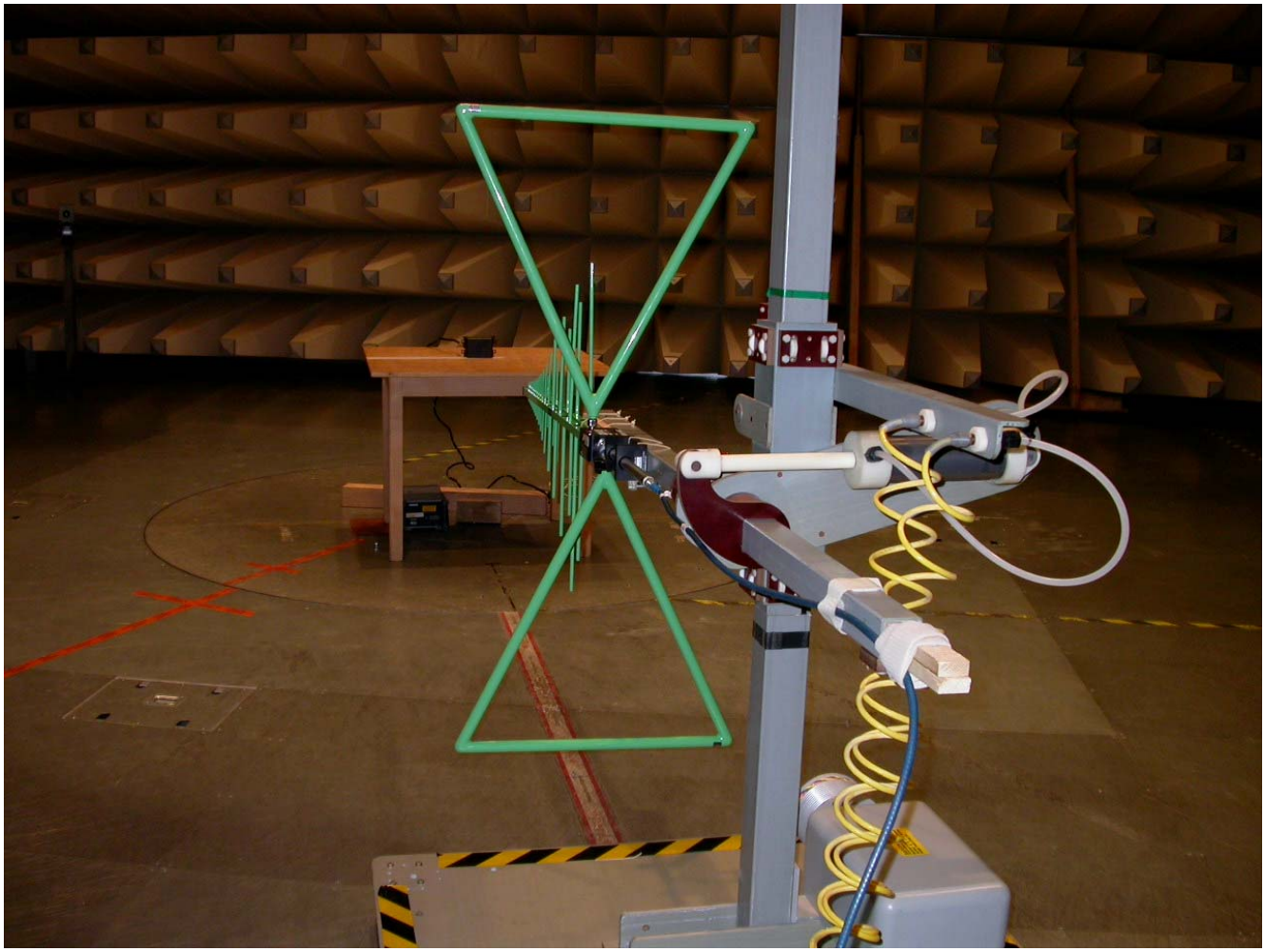
Radiation measurements

Photo 4



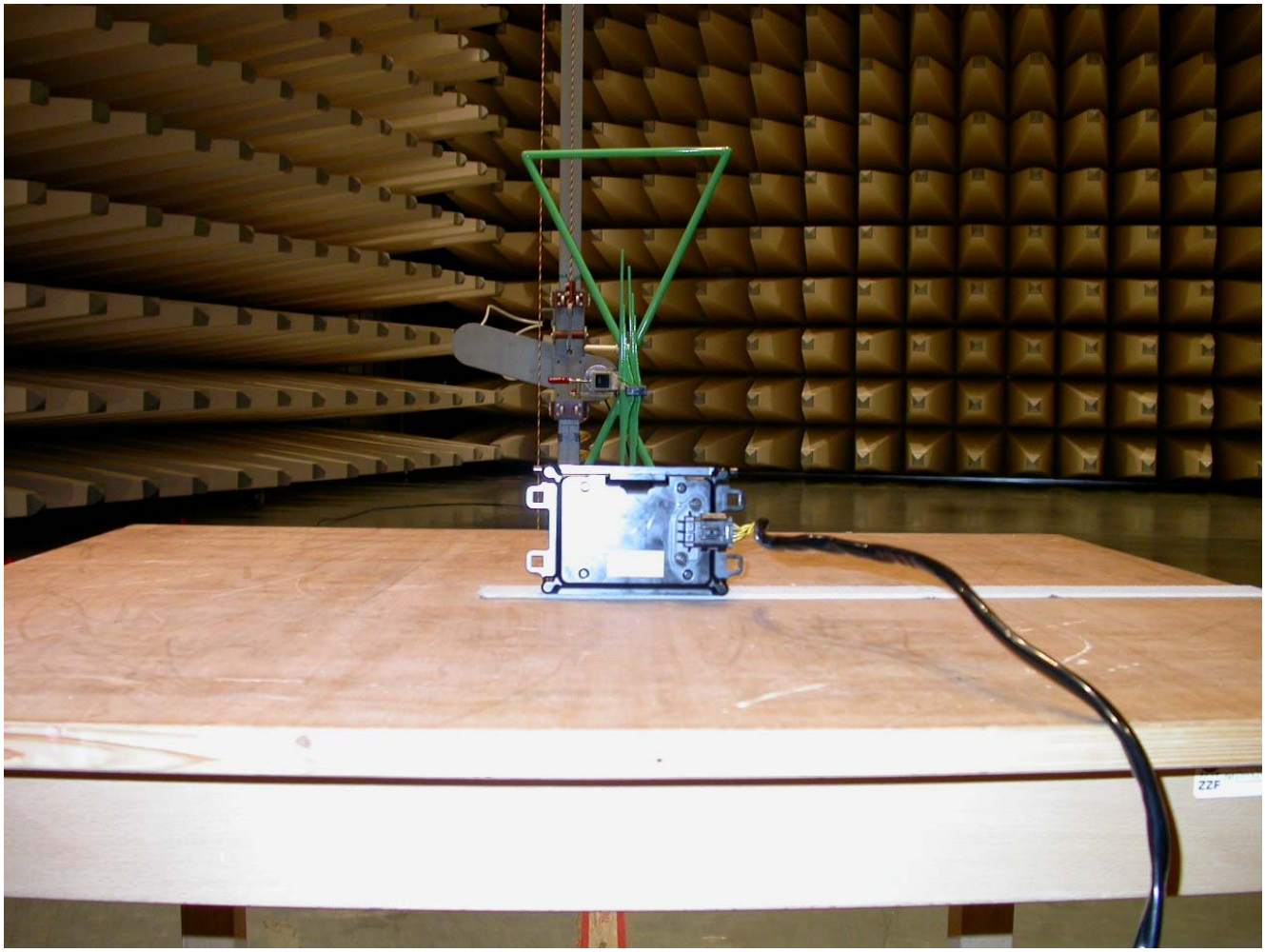
IF Box adapter

Photo 5



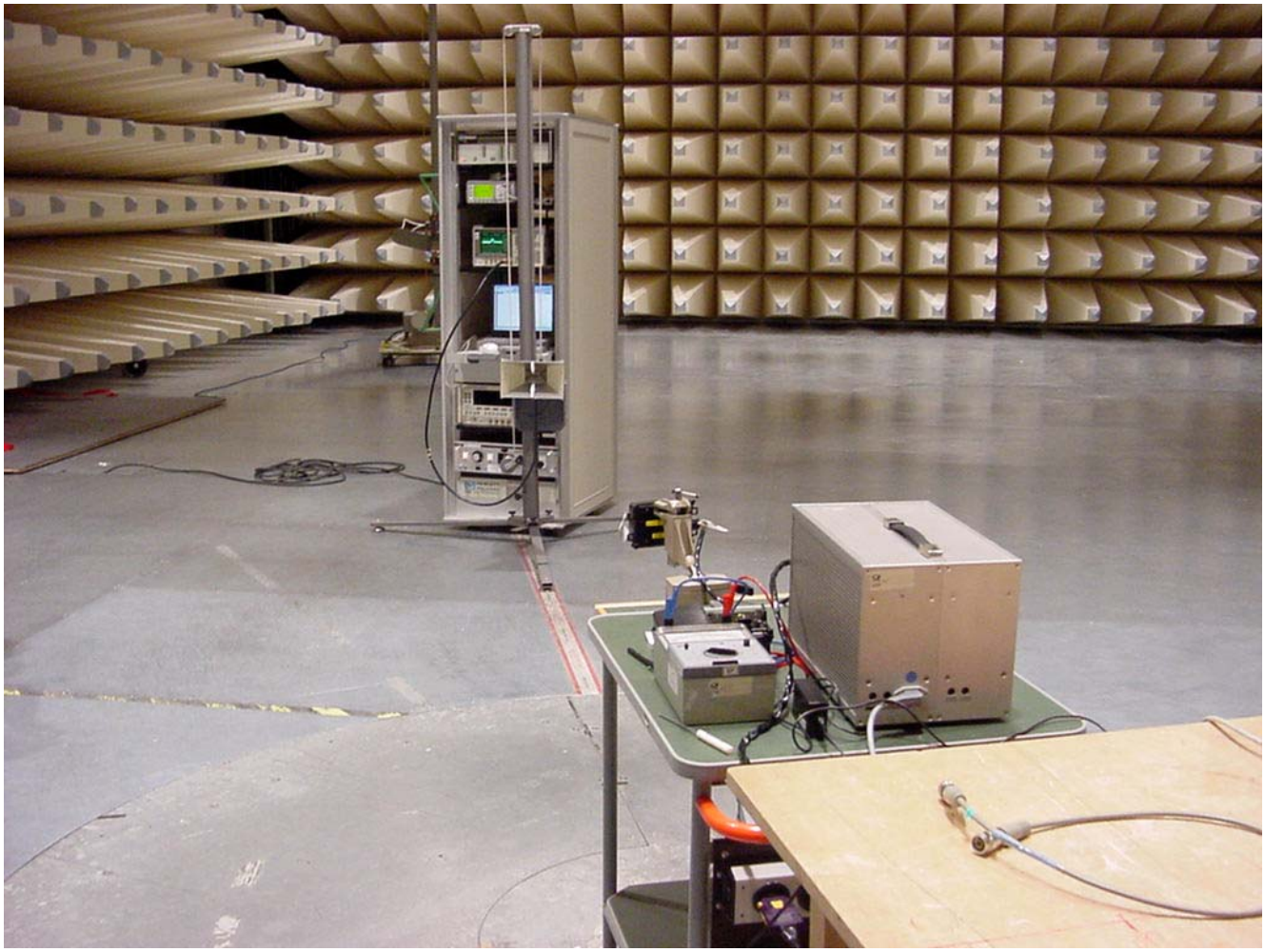
Spurious radiation measurements

Photo 6



Spurious radiation measurements

Photo 7



Spurious radiation measurements

Photo 8

EUT bottom view

Photo 9

EUT side view

Photo 10

EUT with name plate and marking

Photo 11

EUT with name plate and marking

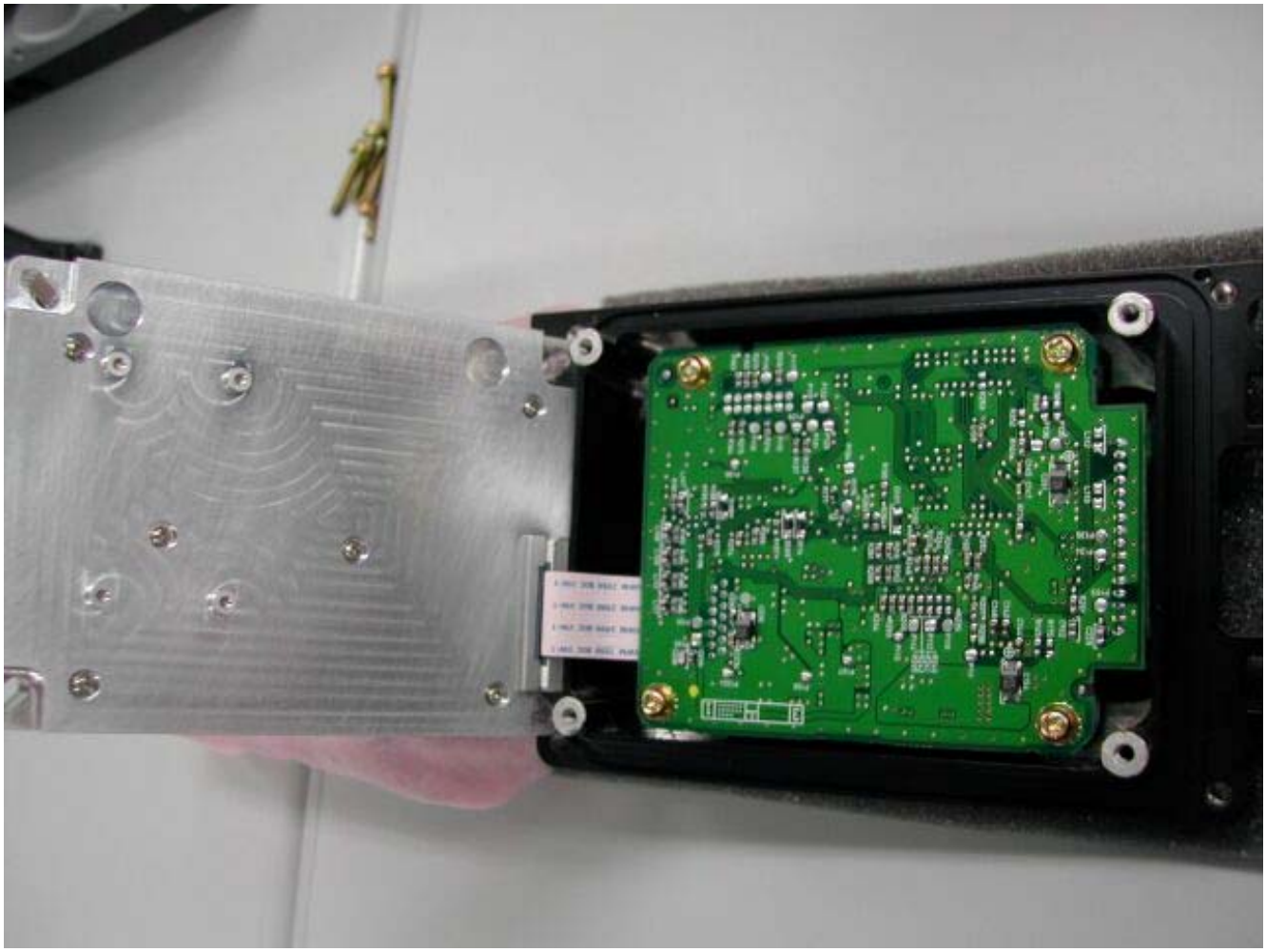
Photo 12

EUT inside view antenna section front side

Photo 13

EUT inside view antenna section back side

Photo 14



EUT inside view

Photo 15

EUT inside view without housing

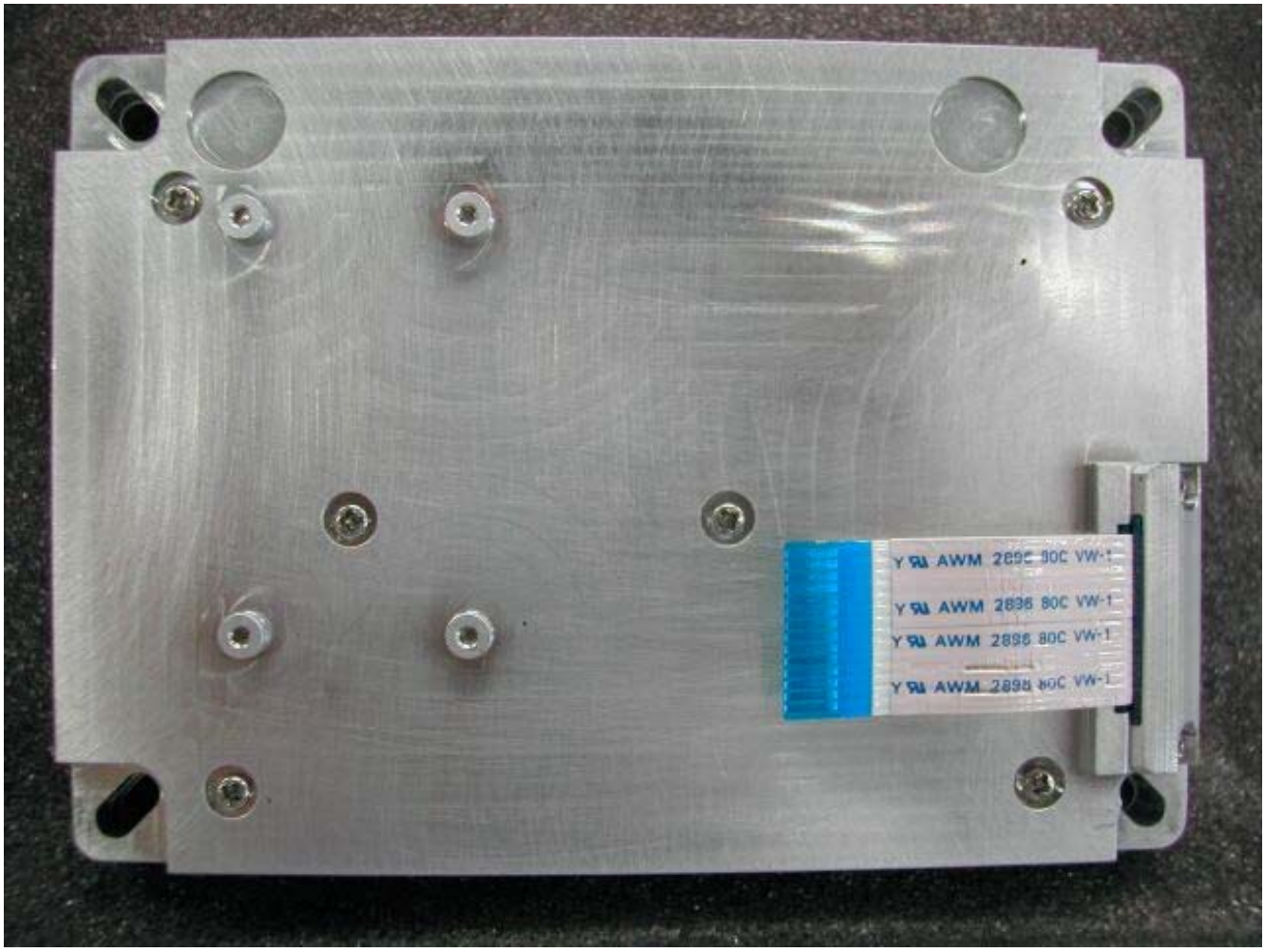
Photo 16

EUT inside view without housing

Photo 17

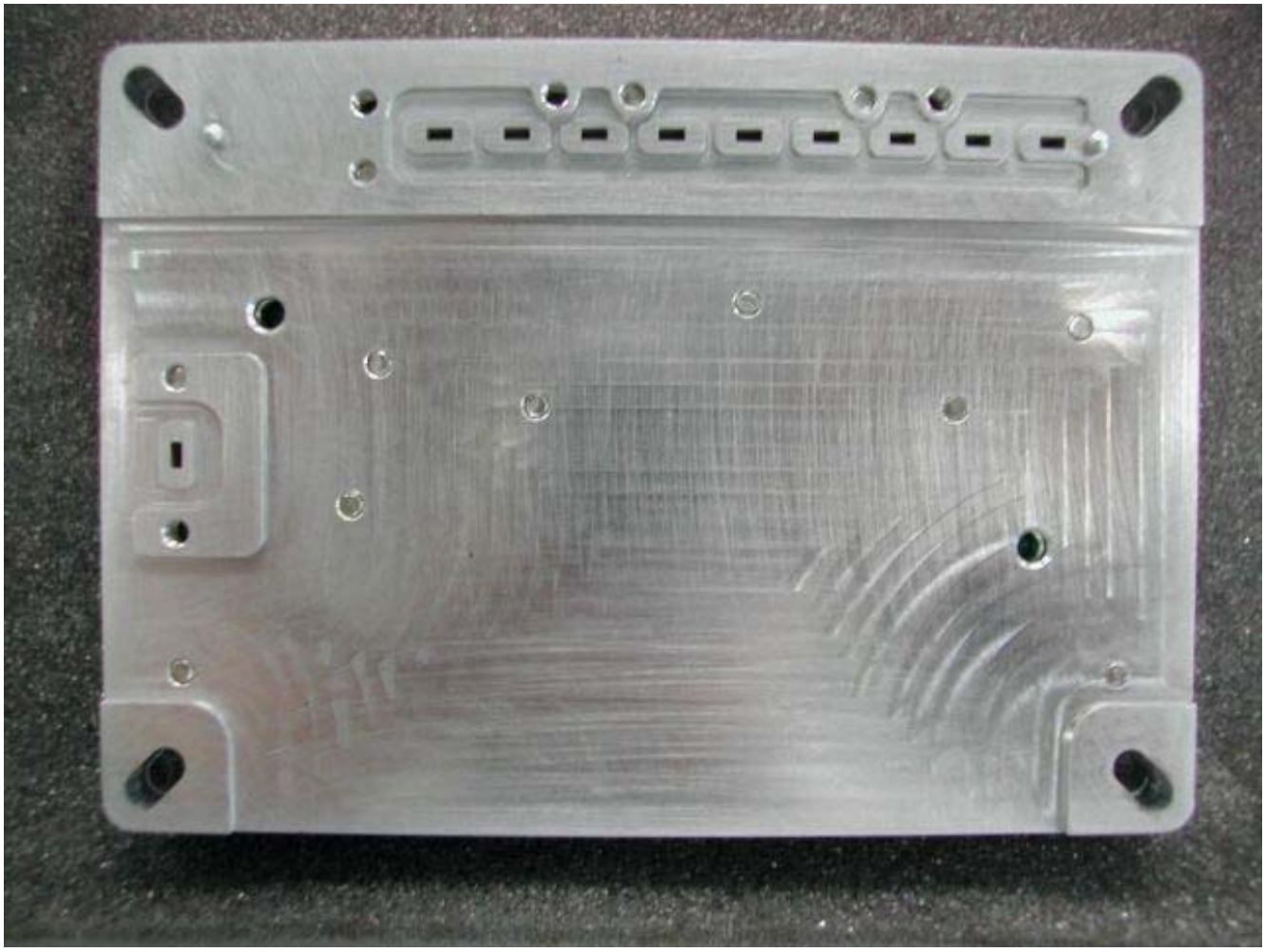
EUT inside view without housing

Photo 18



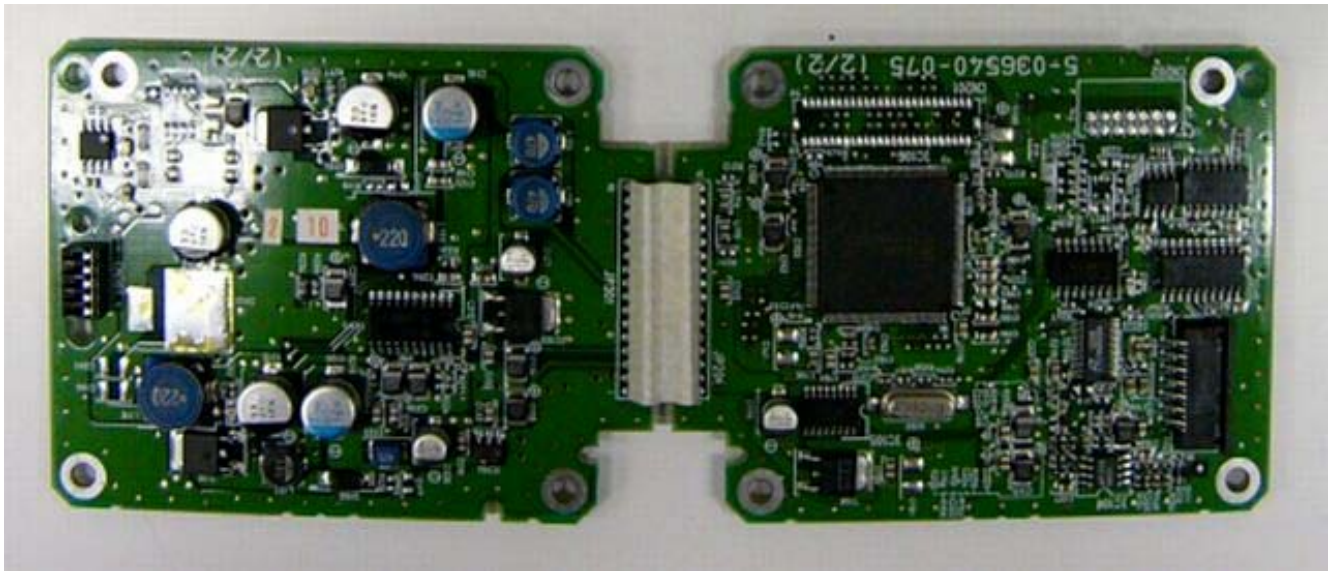
EUT inside view microwave module front side

Photo 19



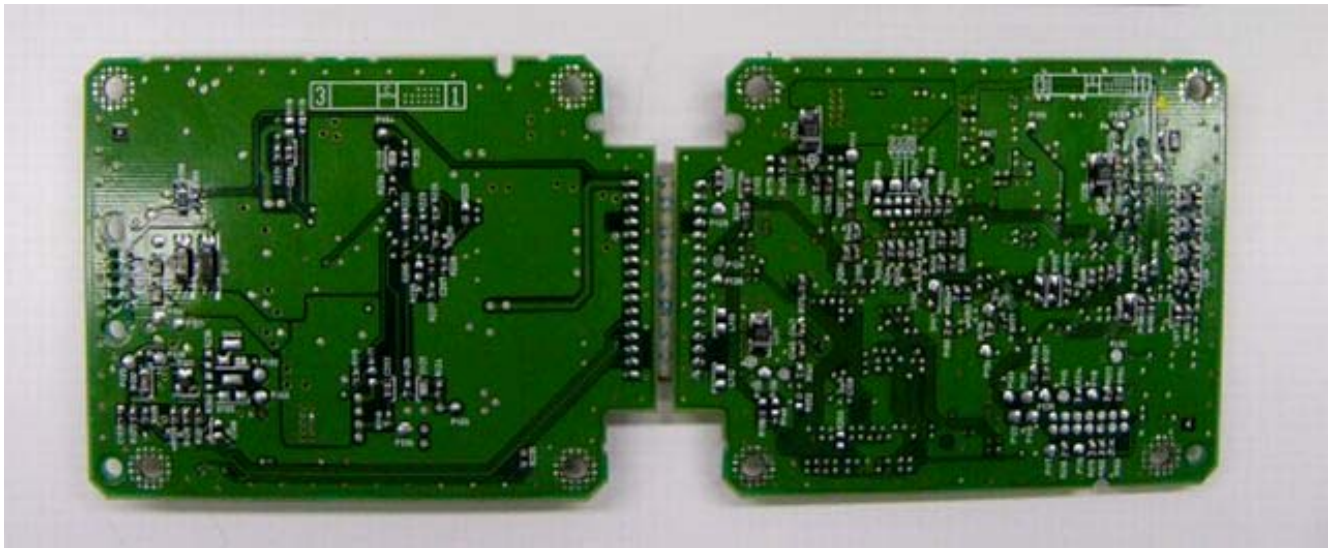
EUT inside view microwave module back side

Photo 20



EUT inside view ECM section

Photo 21



EUT inside view ECM section