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Electrical

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ELECTROMAGNETIC EMISSIONS TEST REPORT

according to FCC Part 15 subpart C, §15.247 and subpart B
for

Tadiran Telematics LTD.

EQUIPMENT UNDER TEST:

Rode-side communication system, RSC-900 Reader and Tag, model RSC-900

Document ID: 154686
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Description of equipment under test

Test items	Road-side communication system
Manufacturer	Tadiran Telematics Israel Ltd.
Brand Mark	RSC-900 Reader and Tag
Types (Models)	RSC-900
Receipt date	March 4, 2001

Applicant information

Applicant's responsible person	Mr. Slava Svitkovski, project manager
Company	Tadiran Telematics Ltd.
Address	26 Hashoftim street, P.O.Box 267
City	Holon, 58102
Country	Israel
Telephone number	+972 3 5575722
Telefax number	+972 3 5564476

Test performance

Project number:	14559
Location	Hermon Laboratories
Test started	March 4, 2001
Test completed	May 2, 2001
Purpose of test	Apparatus compliance verification in accordance with emission requirements
Test specification(s)	FCC Part 15, subpart C, §15.247, 15.205, 15.207, 15.209, subpart B §§15.107, 15.109

1 Summary and signatures

Only the tests listed in the table below were performed. The EUT was found complying with the limits of 47CFR part 15: 1999, 15.247 and part 15, subpart B.

Reader

Parameter	Subclause	C	NC	NT	NA	Reference to remark
Transmitter characteristics, part 15, 15.247						
Occupied bandwidth of hopping channels	(a)(1)(i)	**C**				
Average time of occupancy	(a)(1)(i)	**C**				
Number of hopping channels	(a)(1)(i)	**C**				
Carrier frequency separation	(a)(1)	**C**				
Maximum peak output power	b(2), b(3)	**C**				
Spurious emissions (conducted)	c	**C**				
Spurious emissions (radiated) in restricted bands	c, 15.209	**C**				
Unintentional radiation, part 15, subpart B						
Conducted emissions	15.107, 15.207	**C**				
Radiated emissions	15.109, 15.209	**C**				

NOTE:
C: The parameter is compliant with the requirements.
NC: The parameter is not compliant with the requirements.
NT: The parameter is not tested.
NA: The test of this parameter is not applicable.

Tag

Parameter	Subclause	C	NC	NT	NA	Reference to remark
Unintentional radiation, part 15, subpart B						
Conducted emissions	15.107				**NA**	**See Note**
Radiated emissions	15.109				**NA**	**See Note**

NOTE:
C: The parameter is compliant with the requirements.
NC: The parameter is not compliant with the requirements.
NT: The parameter is not tested.
NA: The test of this parameter is not applicable.

Note. Tag (digital device) was exempt from the specific technical standards and other requirements contained in Part 15 according to 15.103 (a).

Tests performed by:	Mr. Y. Neuman, test engineer	
	Mrs. E. Pitt, test engineer	
Test report prepared by:	Mrs. V. Mednikov, certification engineer	
Test report approved by:	Mr. A. Usoskin, QA manager	

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2 General information

2.1 Abbreviations and acronyms

The following abbreviations and acronyms are applicable to this test report:

AC	alternating current
AE	auxiliary equipment
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μV)	decibel referred to one microvolt
dB(μV/m)	decibel referred to one microvolt per meter
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EUT	equipment under test
GHz	gigahertz
GPS	global positioning system
H	height
Hz	hertz
kHz	kilohertz
kV	kilovolt
L	length
LISN	line impedance stabilization network
m	meter
MHz	megahertz
NA	not applicable
QP	quasi-peak
RF	radio frequency
RE	radiated emission
rms	root mean square
s	second
V	volt
W	width

2.2 Specification references

47CFR part 15: 2001	Radio Frequency Devices
ANSI C63.2:96	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications.
ANSI C63.4:92	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

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2.3 EUT description

The EUT, RSC-900, is a frequency hopping short range communication system which operates in frequency range 904.2 – 925.8 MHz. The EUT consists of two units: a frequency hopping transceiver (reader) and a digital back scattering tag. The system provides bi-directional data transmission by transmitting RF hopping signal from the reader, the tag receives it and stores upon request or provides information requested by the reader by modulating the carrier. The tag has no RF part and provides on-off key modulation of carrier by means of a switching internal antenna. The tag also has an internal GPS receiver.

2.4 EUT test configuration

The EUT ports and lines description is given in Table 2.4.1 and test configuration is shown in Figure 2.4.1.
The highest frequency generated by the EUT is 14 MHz.

Table 2.4.1 EUT ports and lines

Port type	Port description	Indoor/ outdoor cable	Connector type	Quantity	Cable type description	Cable length, m	Connected to
Power + signal **(reader)**	control	outdoor	BINDER, 24 pin, male	1	shielded	25	24VDC to power supply; others – open circuit
RF signal **(reader)**	antenna	outdoor	N-type-f	1	coax	0.3	antenna
Power + signal **(tag)**	control	outdoor	High density D type 44 pin	1	shielded	5.0	24VDC to power supply; others – open circuit

2.4.1 Changes made in EUT

To withstand the standard requirements the following changes were made in the EUT during the testing.

1. five capacitors, 10 pF, were installed between P2 connector (pins 2, 4, 6, 7, 8) and ground;
2. ferrite bead manufactured by Fair-Rite, p/n 0431164181, were installed at flat cables N.5 and 8.

It is manufacturer responsibility to implement the changes in the production version of the EUT. In any case the test report applies to the tested items only.

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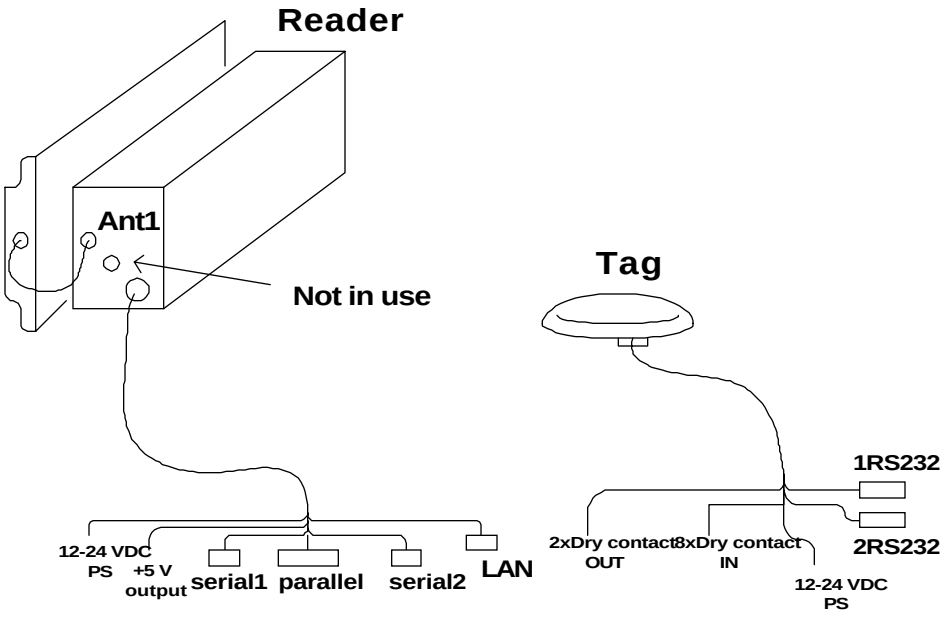
Figure 2.4.1 EUT test configuration



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3 Test facility description

3.1 Test facility description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private EMC, Safety and Telecommunication testing facility. Hermon Laboratories is listed by the Federal Communications Commission (USA) for all parts of Code of Federal Regulations 47 (CFR 47) and by Industry Canada for electromagnetic emissions (file numbers IC 2186-1 for OATS and IC 2186-2 for anechoic chamber), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, C-845 for conducted emissions site), assessed by NMi Certin B.V. (Netherlands) for a number of EMC, Telecommunications, Safety standards, and assessed by AMTAC (UK) for safety of Medical Devices. The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO GUIDE 25/EN 45001 for EMC, Telecommunications and Product Safety Information Technology Equipment (Certificate No. 839.01).

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Person for contact: Mr. Alex Usoskin, QA manager.

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4 Test results

4.1 Occupied bandwidth of hopping channels

4.1.1 General

This test was performed to prove that the maximum 20 dB bandwidth of the hopping channel is less than 500 kHz.

4.1.2 Test procedure

4.1.2.1 The EUT RF output was connected to the spectrum analyzer. The spectrum analyzer settings are shown in the plots.

4.1.2.2 The measurements were performed in normal mode of operation for carrier (channel) frequency at low and high edges and at the middle of the frequency band. Table 4.1.1 and Plots 4.1.1 to 4.1.3 demonstrate the test results of the occupied bandwidth measurements.

4.1.2.3 The EUT was found to be in compliance with the standard requirements and passed the test.

Table 4.1.1 Occupied bandwidth test results

Carrier frequency, MHz	Measured 20 dB BW, kHz	Limit, kHz	Result
904.2	364	500	Pass
915.0	364	500	Pass
925.8	362	500	Pass

Reference numbers of test equipment used

HL 0872	HL 1424

Full description is given in Appendix A.

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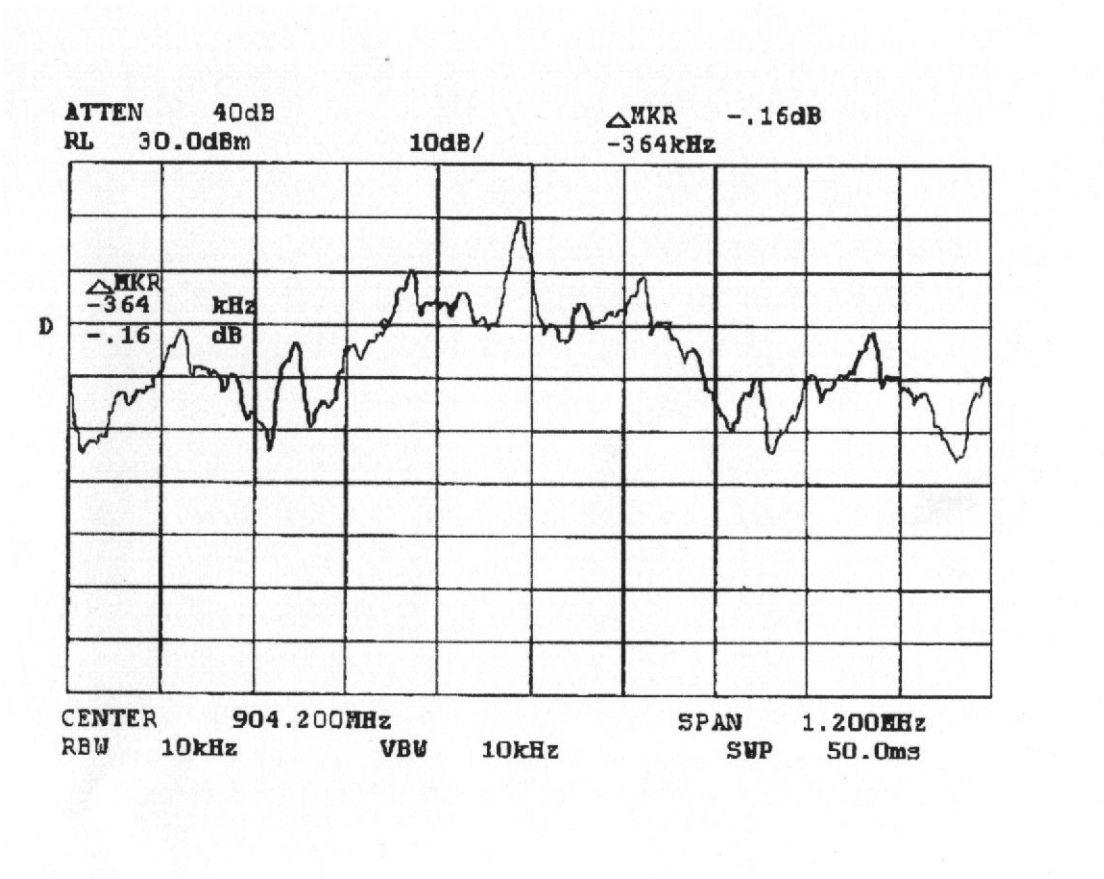
Plot 4.1.1 20 dB bandwidth for hopping system



20 dB bandwidth is 364 kHz(<500 kHz).

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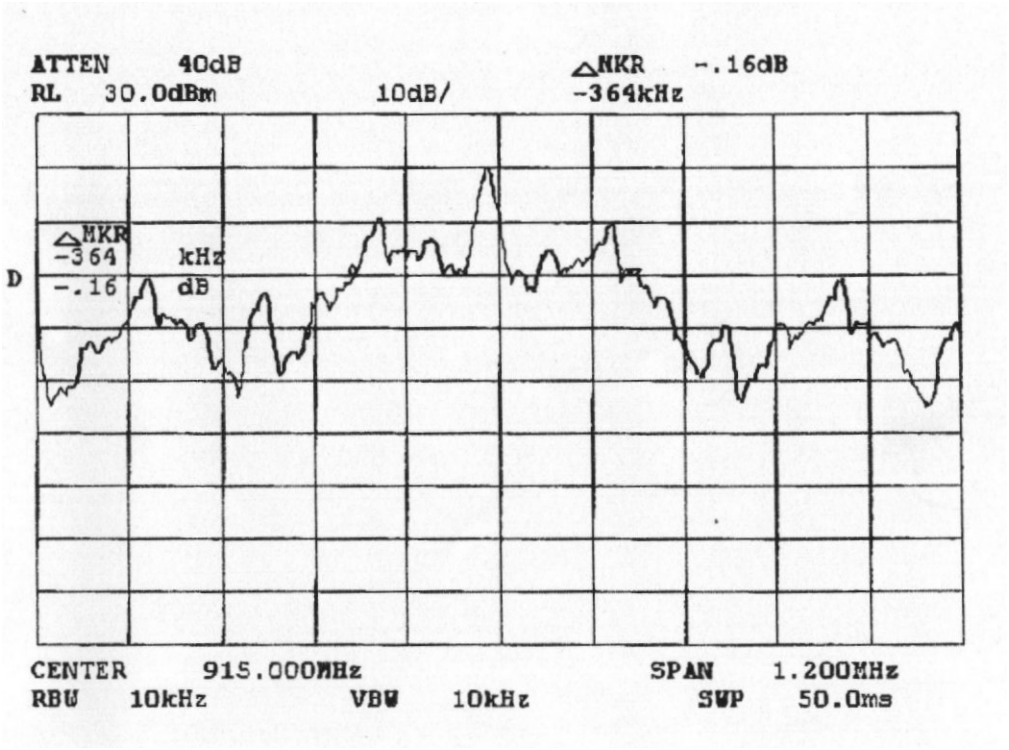
Plot 4.1.2 20 dB bandwidth for hopping system



20 dB bandwidth is 364 kHz(<500 kHz).

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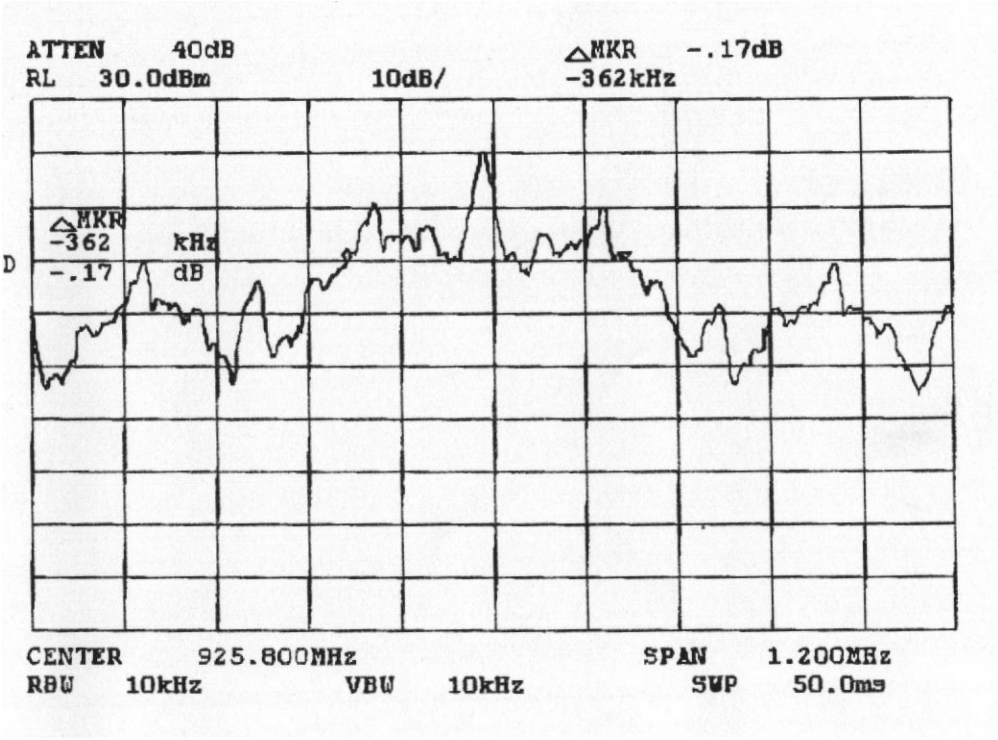
Plot 4.1.3 20 dB bandwidth for hopping system



20 dB bandwidth is 362 kHz(<500 kHz).

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4.2 Frequency hopping channels separation and hopping frequency usage test according to §15.247(a)(1)(ii)

4.2.1 General

This test was performed to prove that the EUT frequency hopping system uses at least 25 hopping frequencies and has the 20 dB bandwidth of the hopping channel 250 kHz or greater. The frequency hopping channels separation shall be greater than 20 dB bandwidth.

4.2.2 Test procedure

4.2.2.1 The EUT RF output was connected to the spectrum analyzer. The spectrum analyzer settings are shown in the plots.

4.2.2.2 Plots 4.2.1 to 4.2.2 show the hopping channel frequency separation and the number of hopping channels.

4.2.2.3 The EUT was found to be in compliance with the standard requirements and passed the test.

Reference numbers of test equipment used

HL 0872	HL 1424

Full description is given in Appendix A.

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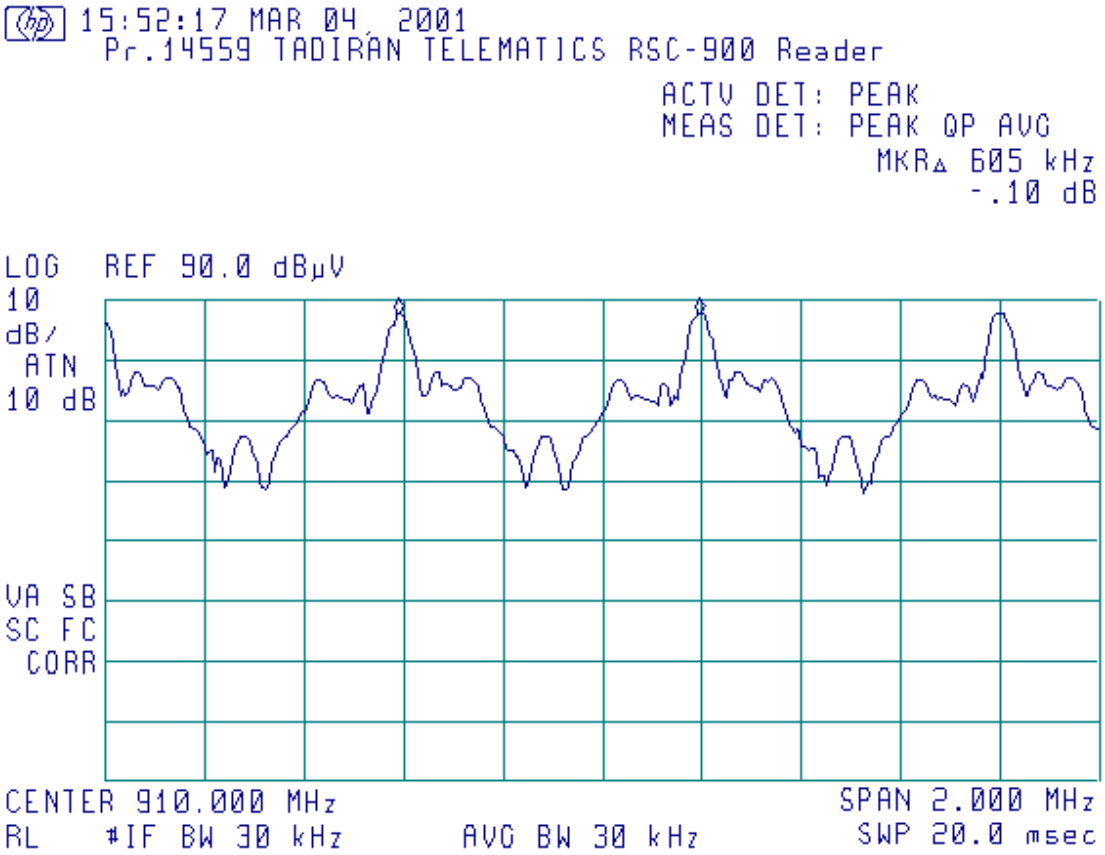
Plot 4.2.1 Hopping channel frequency separation



Carrier frequency separation is 605 kHz, which is greater than 364 kHz (occupied 20 dB bandwidth, refer to Paragraph 4.1)

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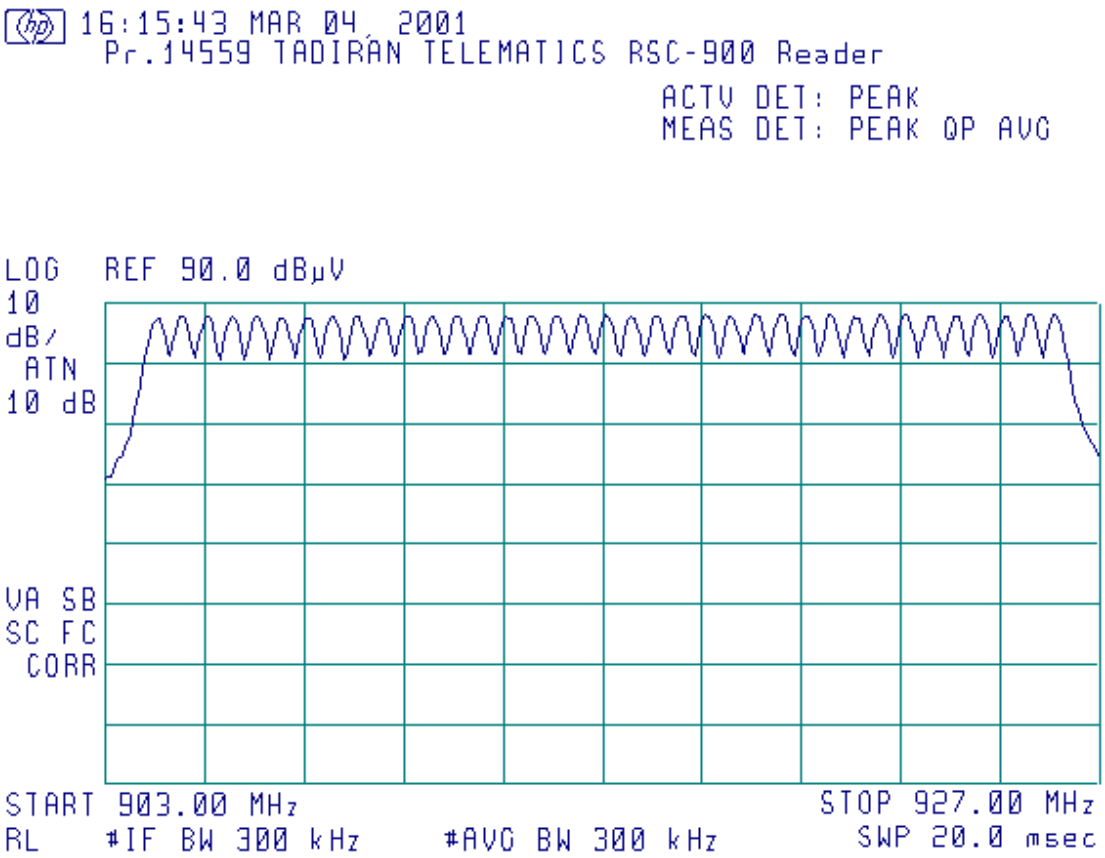
Plot 4.2.2 The number of hopping channels



The number of hopping channels is 37 (>25).

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4.3 Average time of occupancy, definition according to § 15.247(a)(1)(ii)

4.3.1 General

The test was performed to prove that the average time of occupancy at any frequency is not greater than 0.4 seconds within any 10 second period.

4.3.2 Test procedure

4.3.2.1 The EUT RF output was connected to the spectrum analyzer.

4.3.2.2 In 10 s time interval, 3 periods of occupancy were found. Each period duration was 95 ms. Hence average time of occupancy within a 10 s interval is 95 ms x 3 = 285 ms < 0.4 s.

4.3.2.3 The EUT was found to be in compliance with the standard requirements and passed the test.

Reference numbers of test equipment used

HL 0872	HL 1424

Full description is given in Appendix A.

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4.4 Maximum peak output power test according to §15.247 (b)(2), (b)(3)

4.4.1 General

This test was performed to demonstrate that the maximum RF peak output power of the transmitter does not exceed 250 mW (24 dBm) (§15.247 (1)).
If directional transmitting antenna gain is greater than 6 dBi, a peak output power of an intentional radiator shall be reduced below the stated value by the amount in dB that a directional gain of an antenna exceeds 6 dBi (§15.247 (3)).
In our case antenna gain is 7.5 dBi, hence the maximum peak output power of the transmitter shall not exceed 24 – (7.5-6) = 22.5 dBm

4.4.2 Test procedure

4.4.2.1 The EUT RF output was connected to the spectrum analyzer, which settings are shown in the plots.

4.4.2.2 Test results are recorded in the Table 4.4.1 and shown in Plots 4.4.1 to 4.4.3.

4.4.2.3 The EUT was found to be in compliance with the standard requirements and passed the test.

Table 4.4.1
Transmitter output RF power test results

Frequency, MHz	Peak output power, dBm	Limit, dBm	Margin, dB	Result
904.2	20.00	22.5	2.5	Pass
915.0	20.1	22.5	2.4	Pass
925.8	20.35	22.5	2.15	Pass

Reference numbers of test equipment used

HL 0872	HL 1424

Full description is given in Appendix A.

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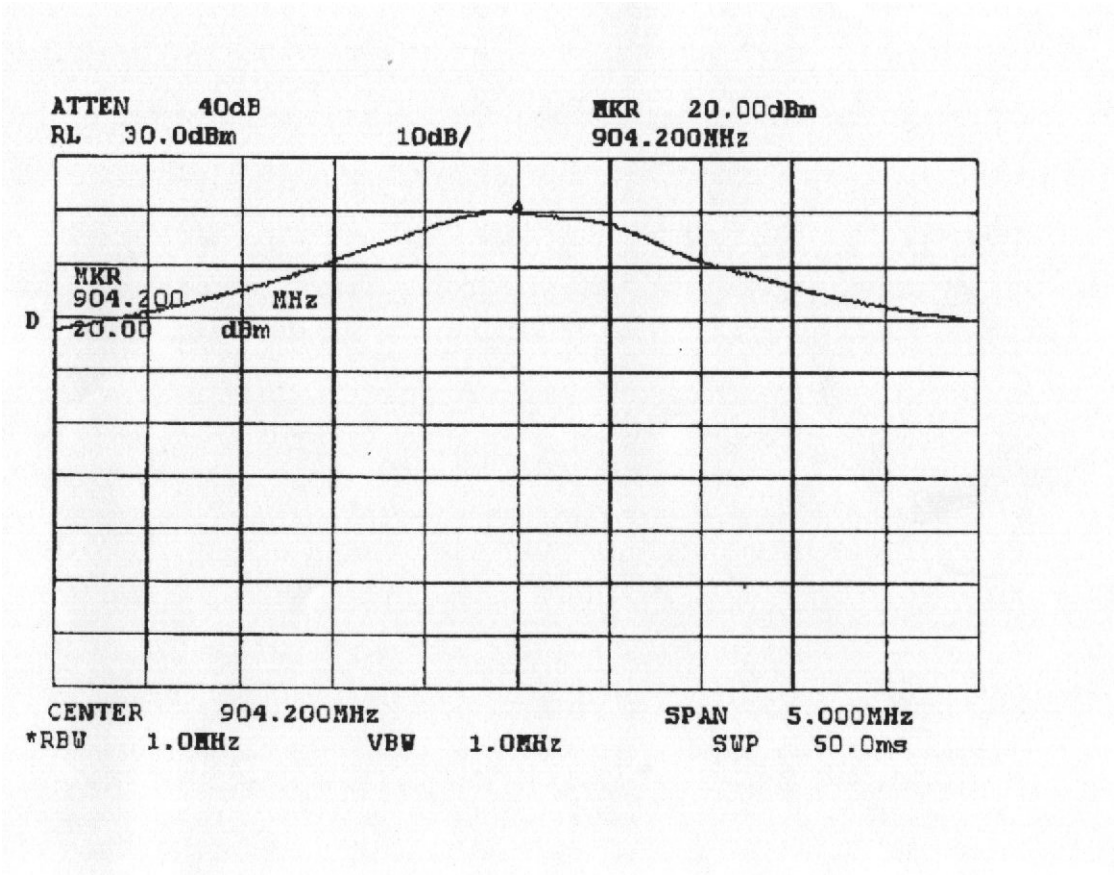
Plot 4.4.1

Transmitter output RF power test results, the lowest frequency



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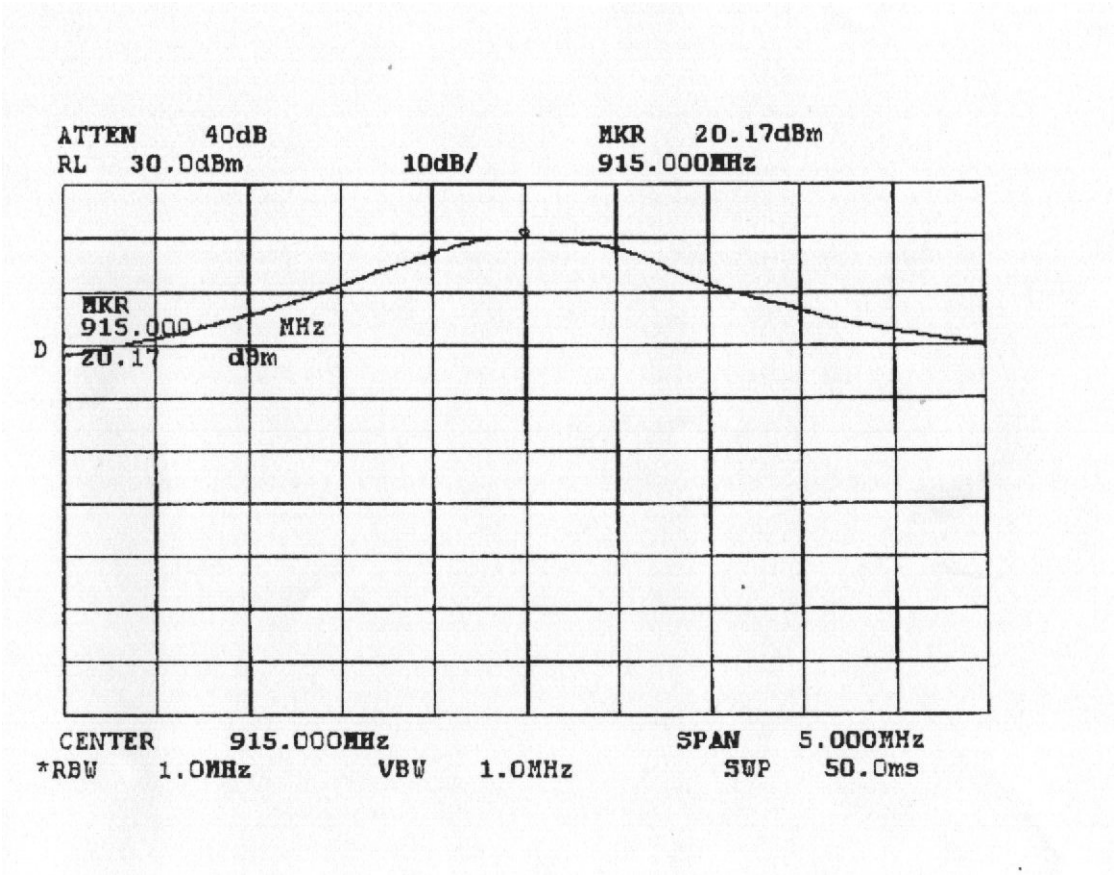
Plot 4.4.2

Transmitter output RF power test results, middle frequency



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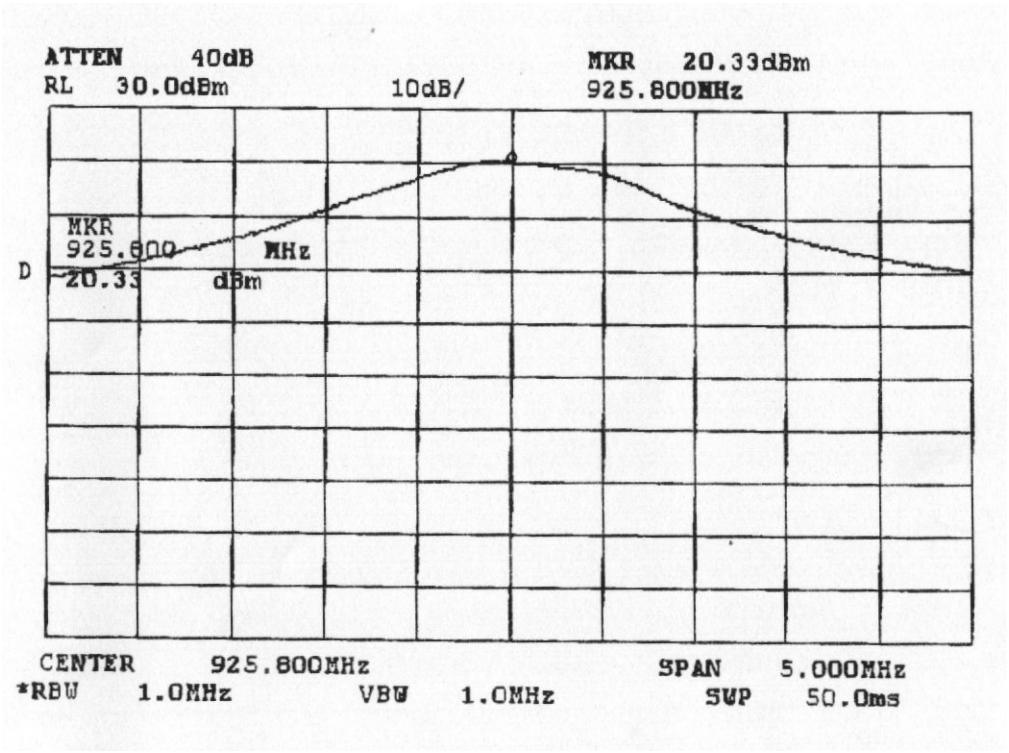
Plot 4.4.3

Transmitter output RF power test results, the highest frequency



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4.5 Out of band antenna conducted emissions test according to §15.247(c)

4.5.1 General

This test was performed to prove that the EUT out-of-band emissions in any 100 kHz bandwidth outside 2.400 to 2.4835 GHz are at least 20 dB below maximum power content as measured in any 100 kHz bandwidth within the band that contains the highest level of the desired power.

4.5.2 Test procedure

4.5.2.1 The EUT RF output was connected to the spectrum analyzer. The spectrum analyzer settings are shown in the plots.

4.5.2.2 The test was performed for the EUT in transmitting and in receive mode with modulation and active hopping from 9 kHz to the 10^{th} harmonic. Plots 4.5.1 to 4.5.19 show that the out of bands measured signals were attenuated more than 20 dBc (i.e. all signals were found less than 0 dBm, refer to Paragraph 4.4).

4.5.2.3 The EUT was found to be in compliance with the standard requirements and passed the test.

Reference numbers of test equipment used

HL 0411	HL 1424

Full description is given in Appendix A.

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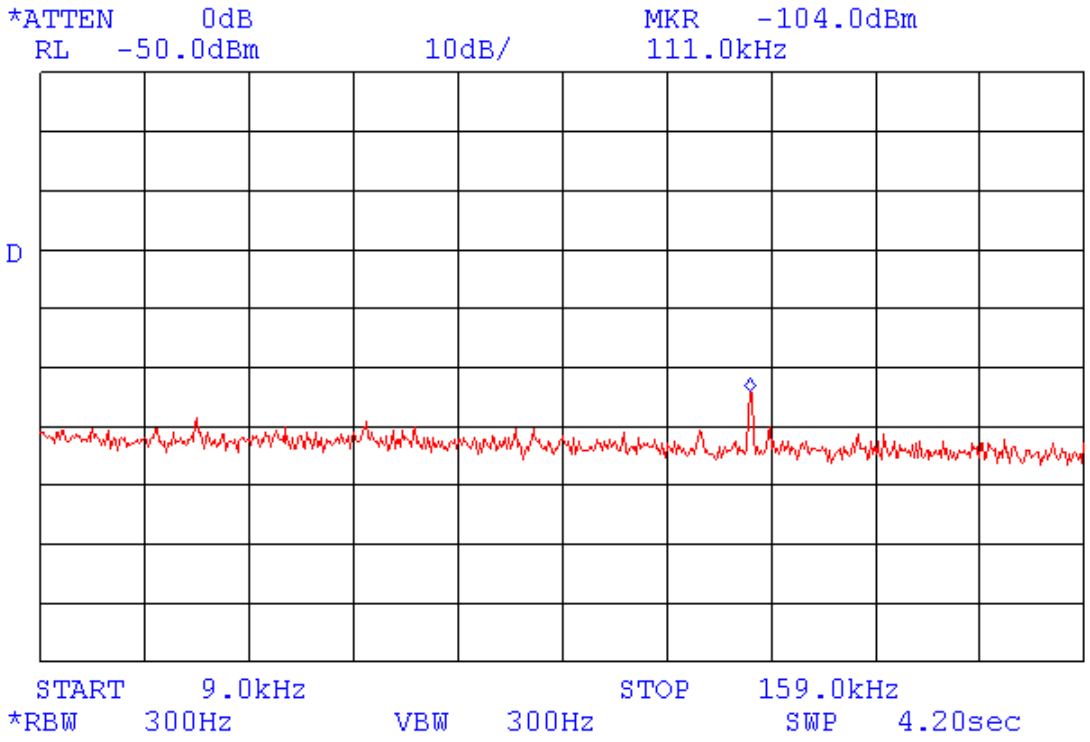
Plot 4.5.1

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
Frequency range 9 kHz - 159 kHz



No external attenuation

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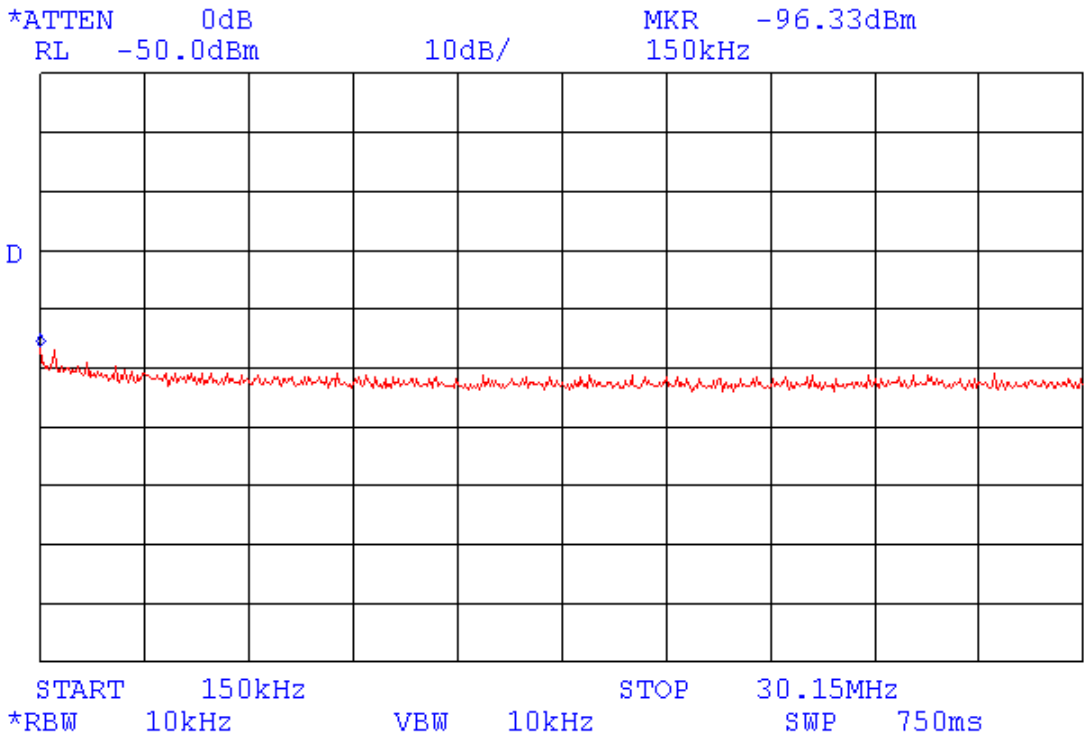
Plot 4.5.2

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
Frequency range 150 kHz - 30 MHz



No external attenuation

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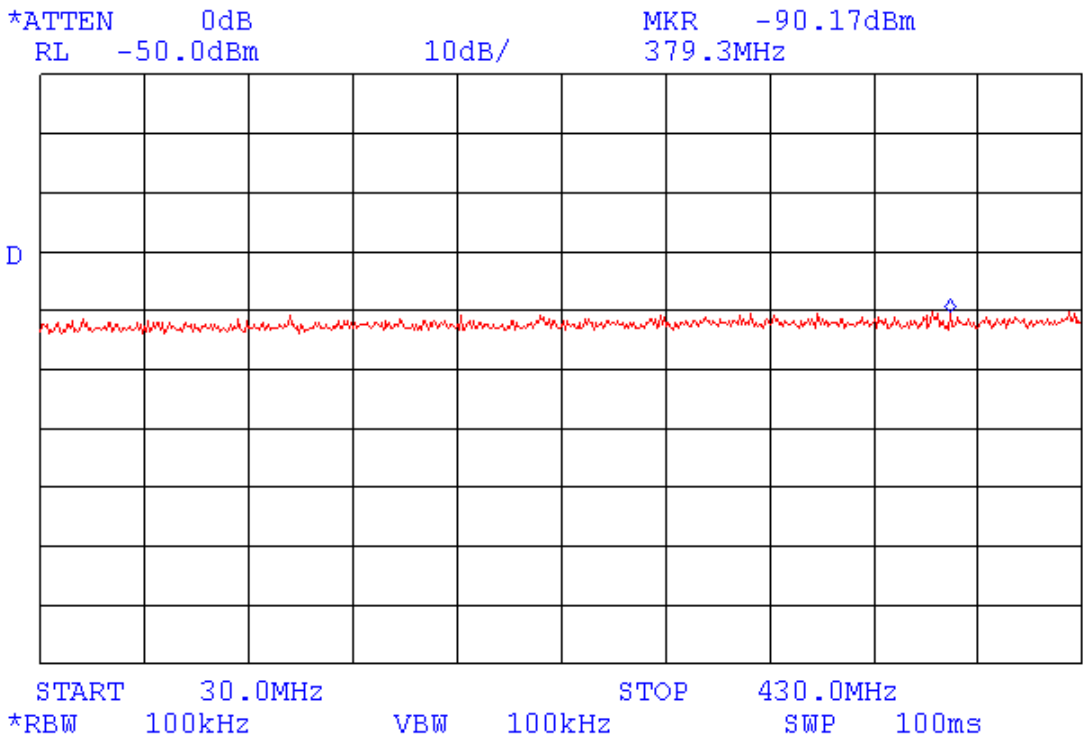
Plot 4.5.3

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
Frequency range 30 MHz – 430 MHz



External attenuation 40 dB

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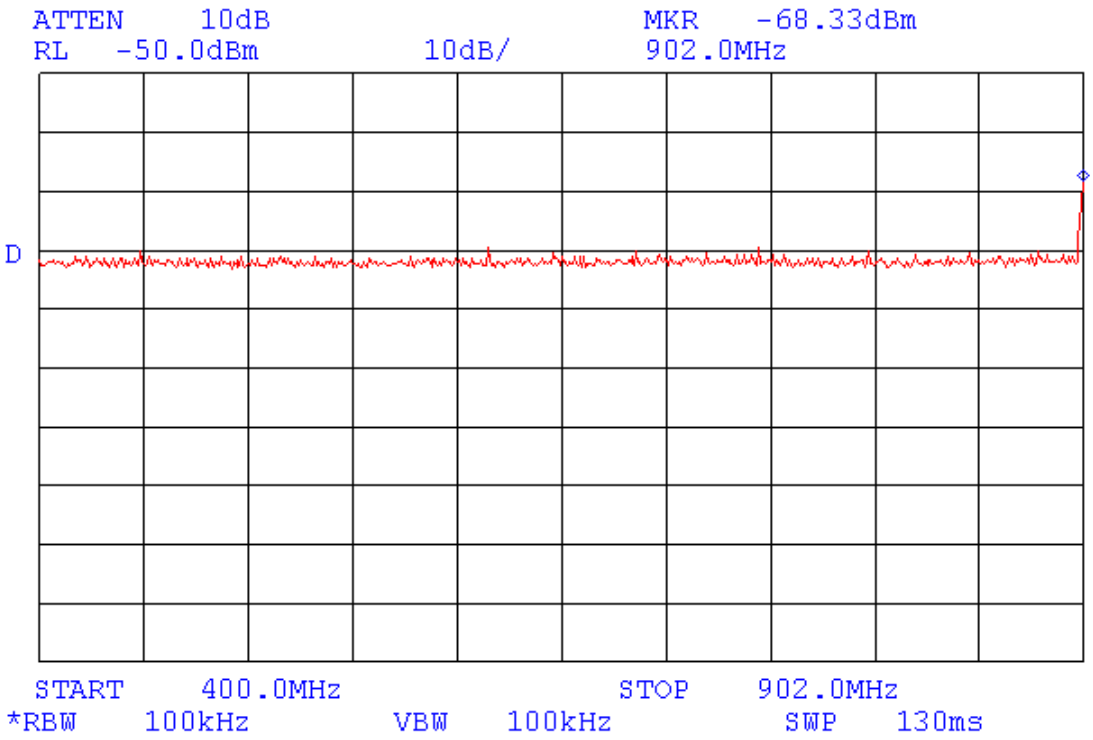
Plot 4.5.4

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
Frequency range 400 MHz - 902 MHz



External attenuation 40 dB

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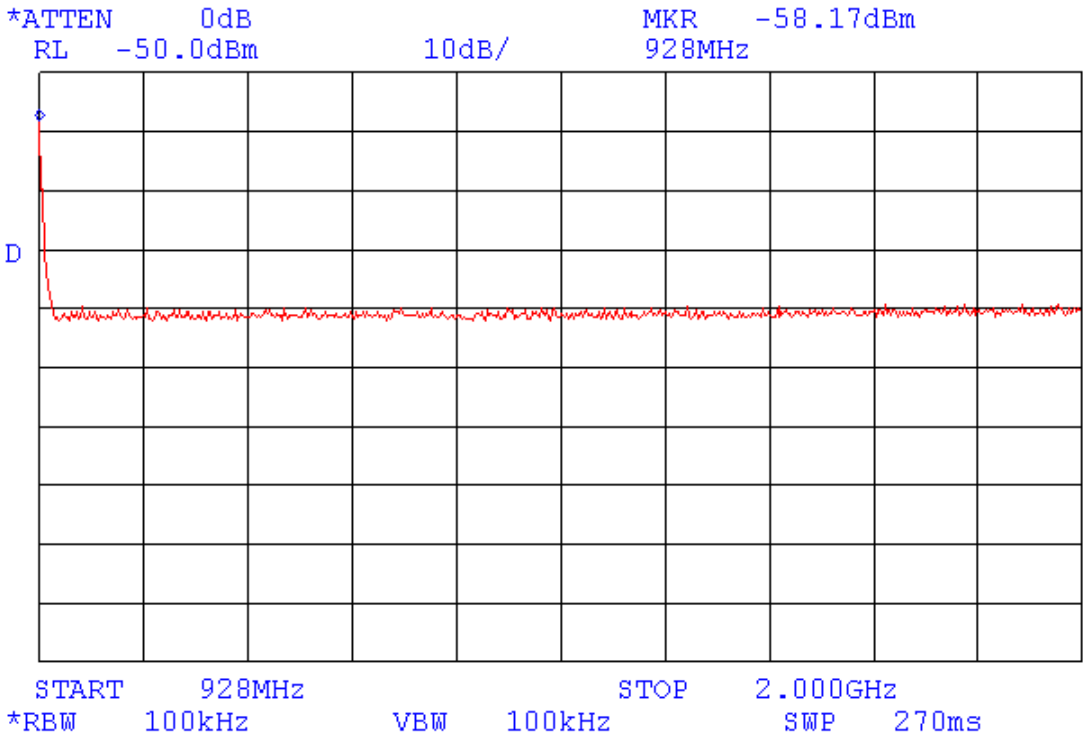
Plot 4.5.5

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
Frequency range 928 MHz – 2.0 GHz



External attenuation 40 dB

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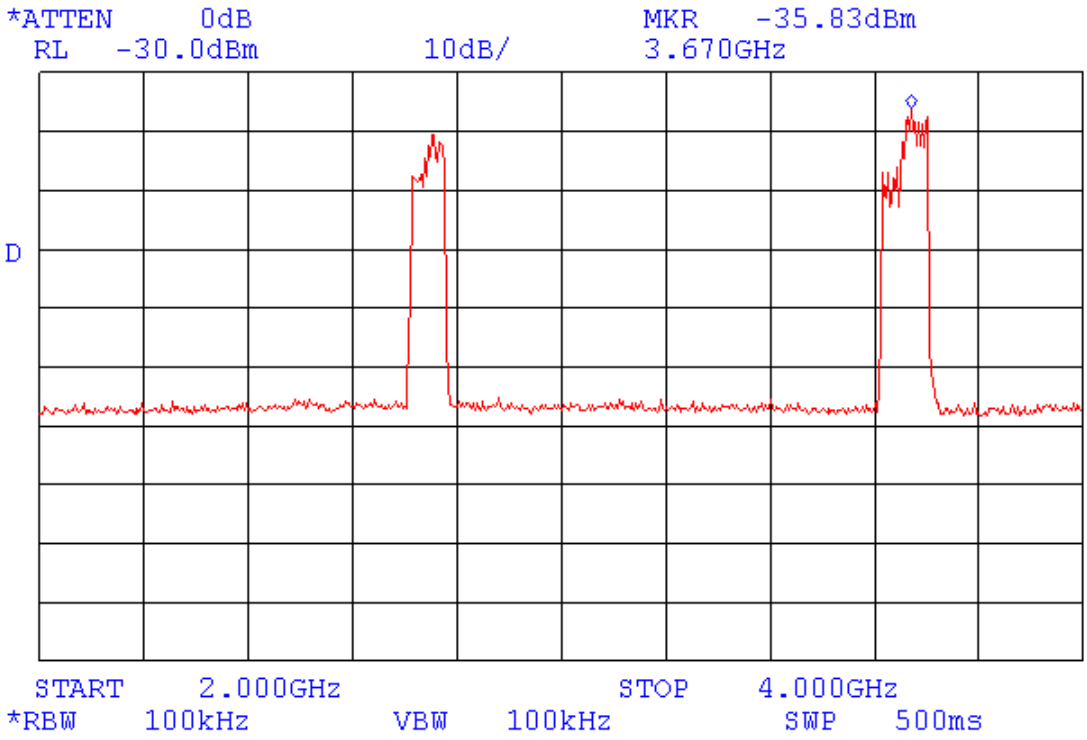
Plot 4.5.6

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
Frequency range 2.0 MHz – 4.0 GHz



No external attenuation

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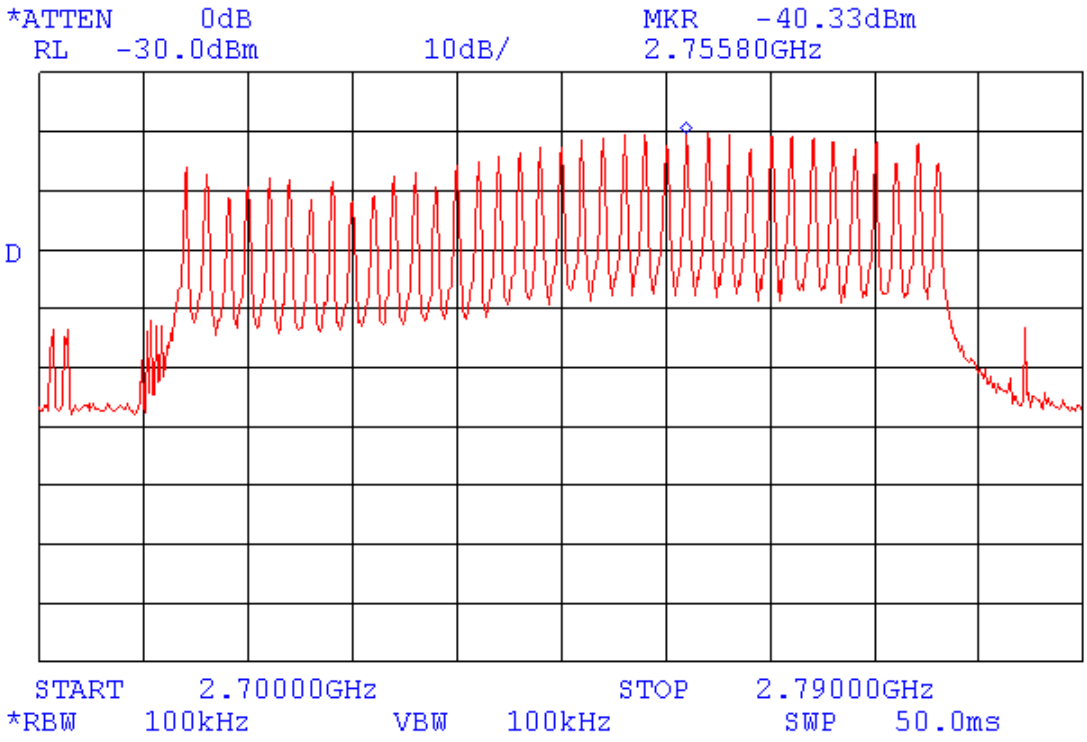
Plot 4.5.7

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
The 3rd harmonic of carrier



No external attenuation

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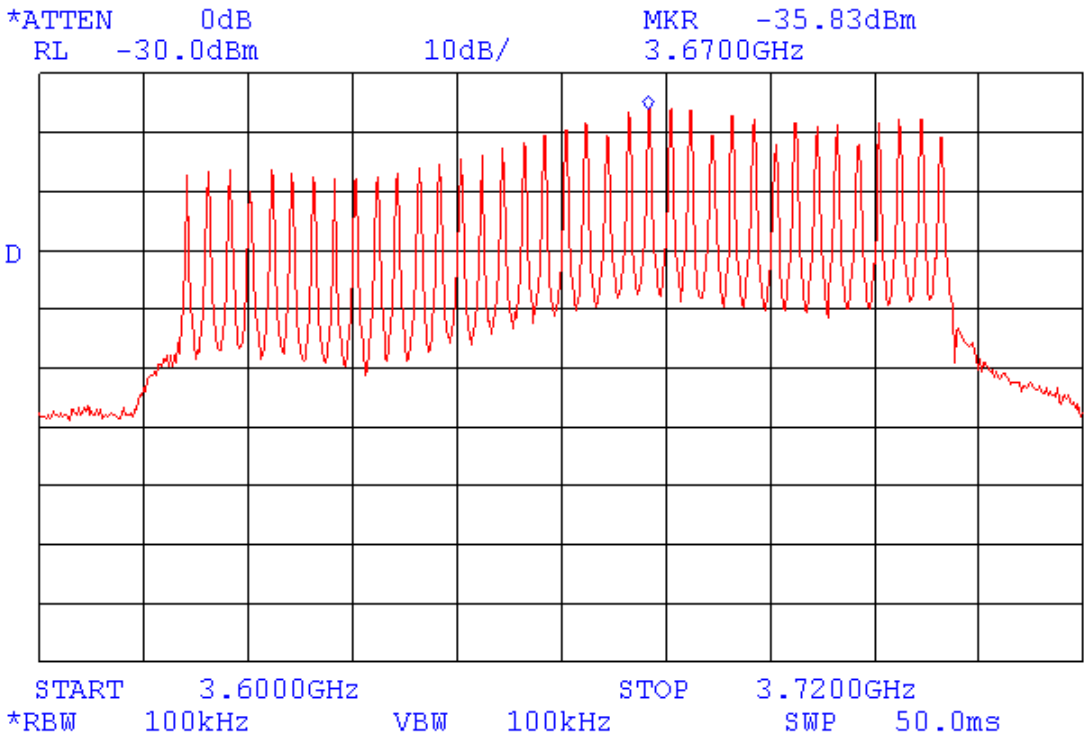
Plot 4.5.8

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
The 4th harmonic of carrier



No external attenuation

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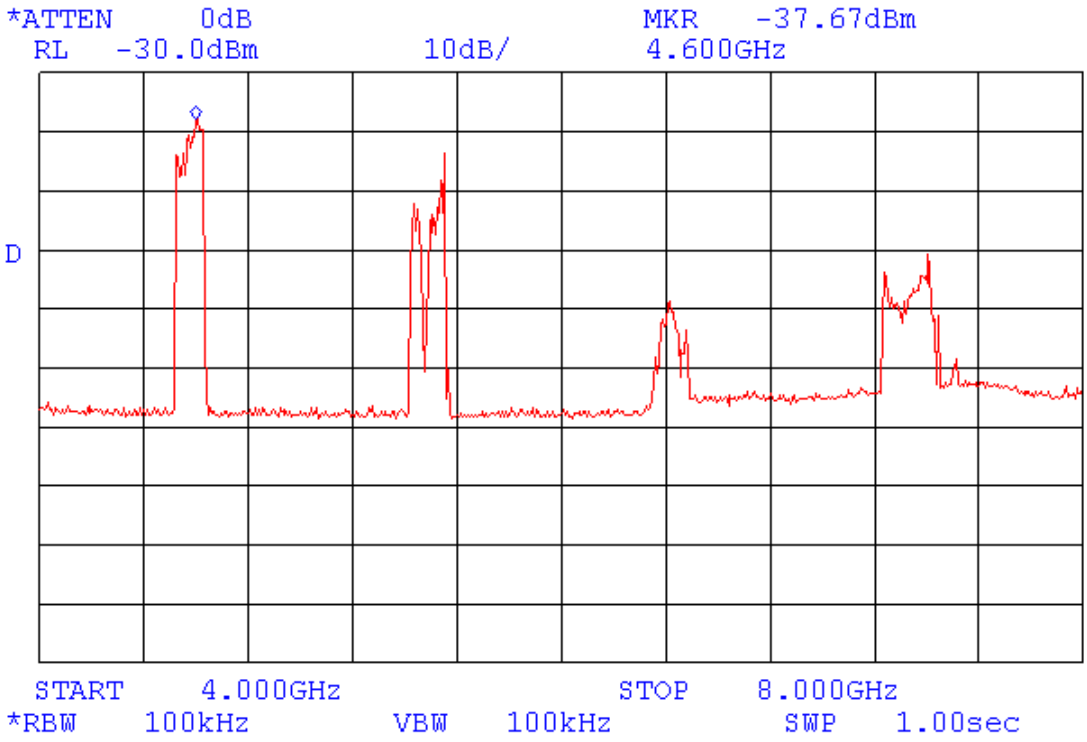
Plot 4.5.9

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
Frequency range 4.0 GHz – 8.0 GHz



No external attenuation

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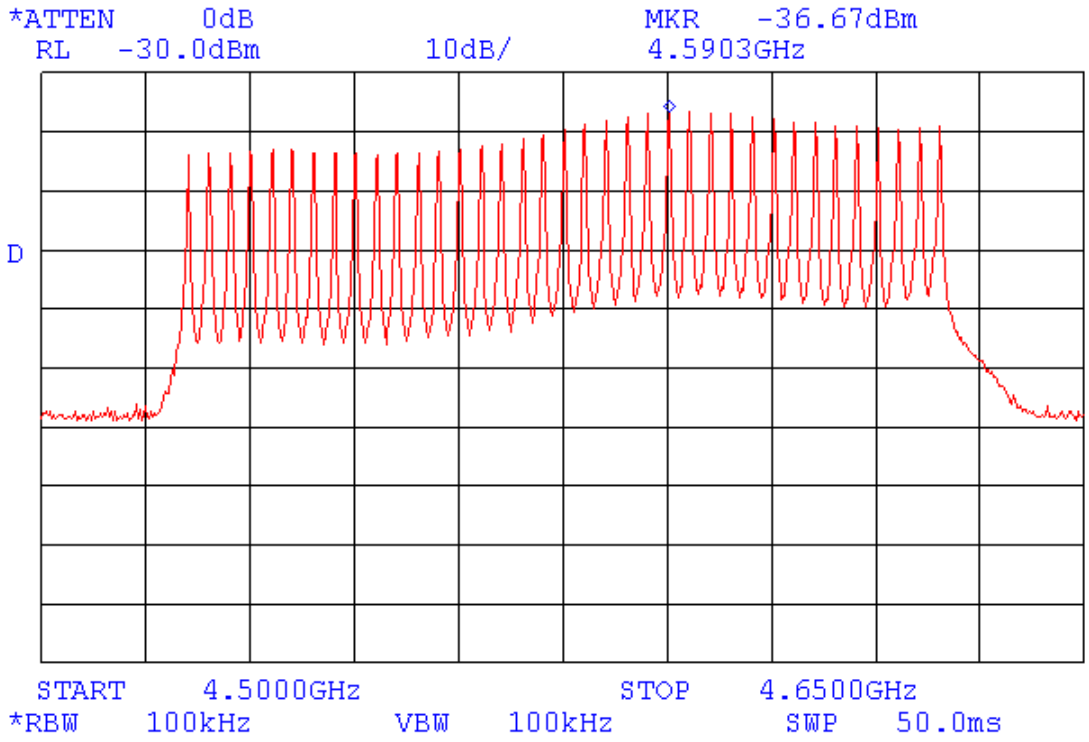
Plot 4.5.10

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
The 5th harmonic of carrier



No external attenuation

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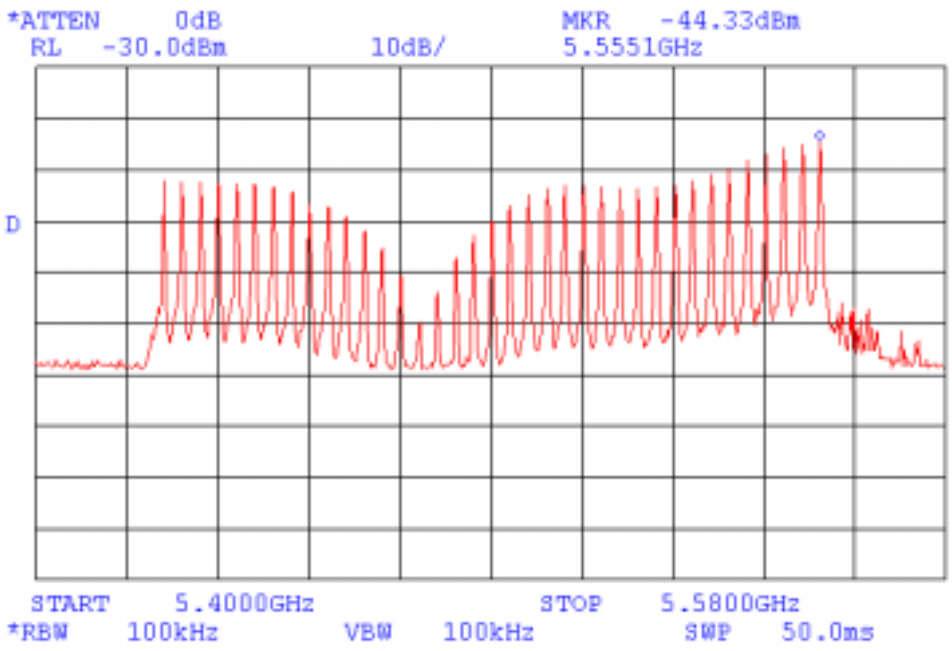
Plot 4.5.11

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
The 6th harmonic of carrier



No external attenuation

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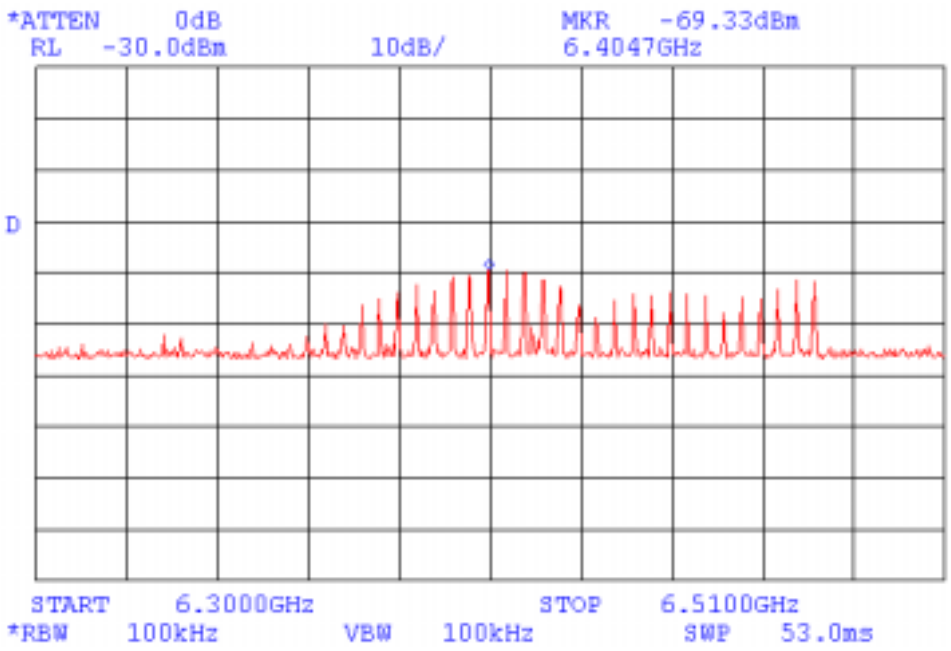
Plot 4.5.12

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
The 7th harmonic of carrier



No external attenuation

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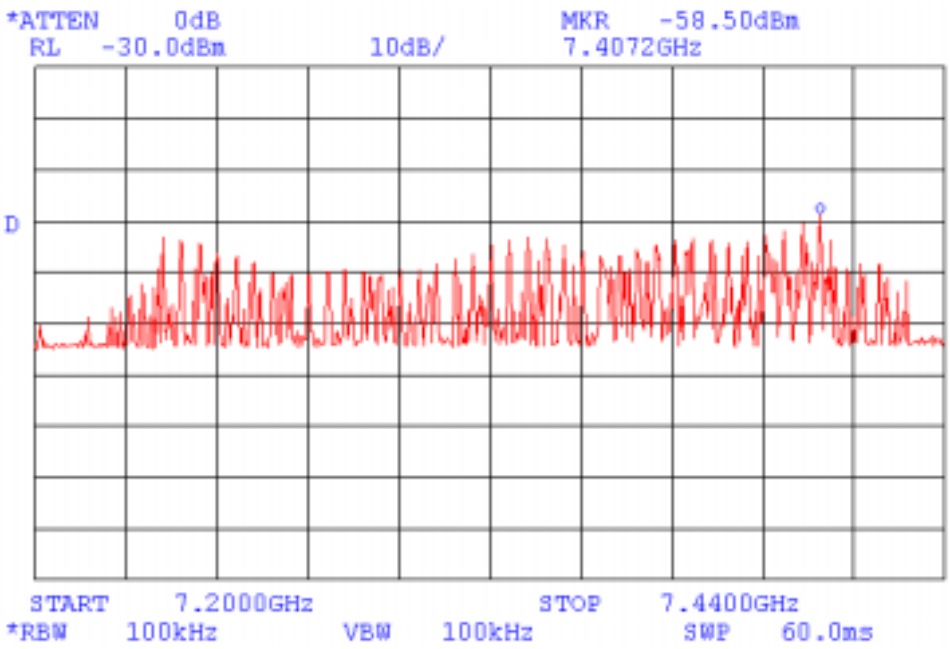
Plot 4.5.13

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
The 8th harmonic of carrier



No external attenuation

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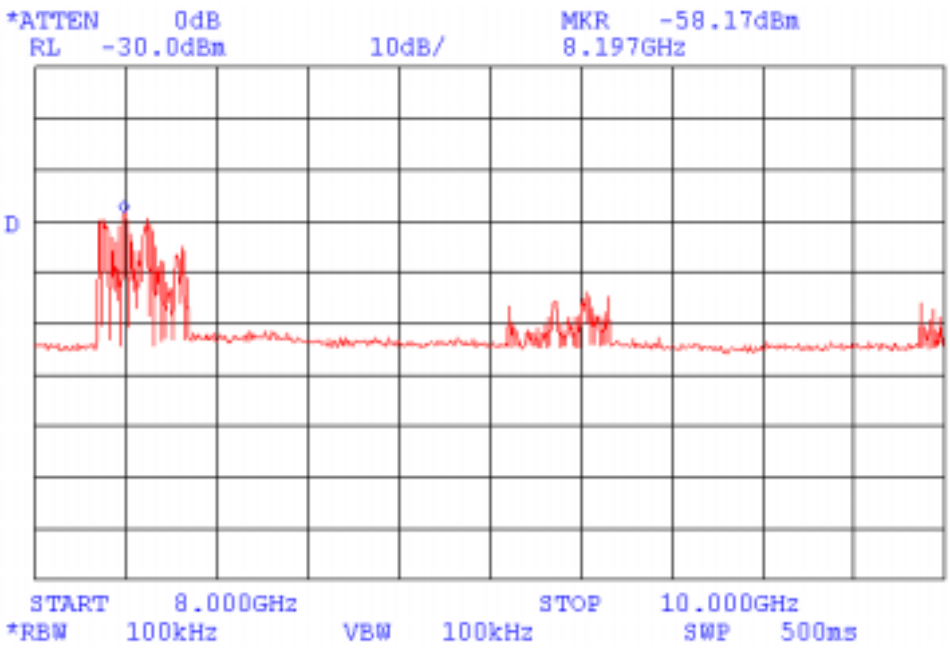
Plot 4.5.14

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
Frequency range 8.0 GHz - 10 GHz



No external attenuation

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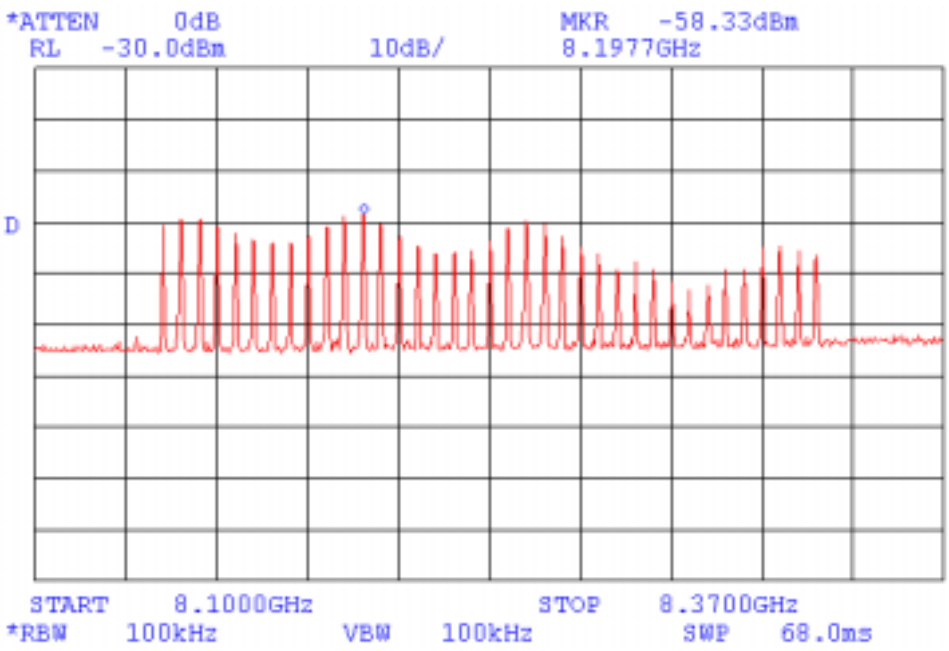
Plot 4.5.15

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
The 9th harmonic of carrier



No external attenuation

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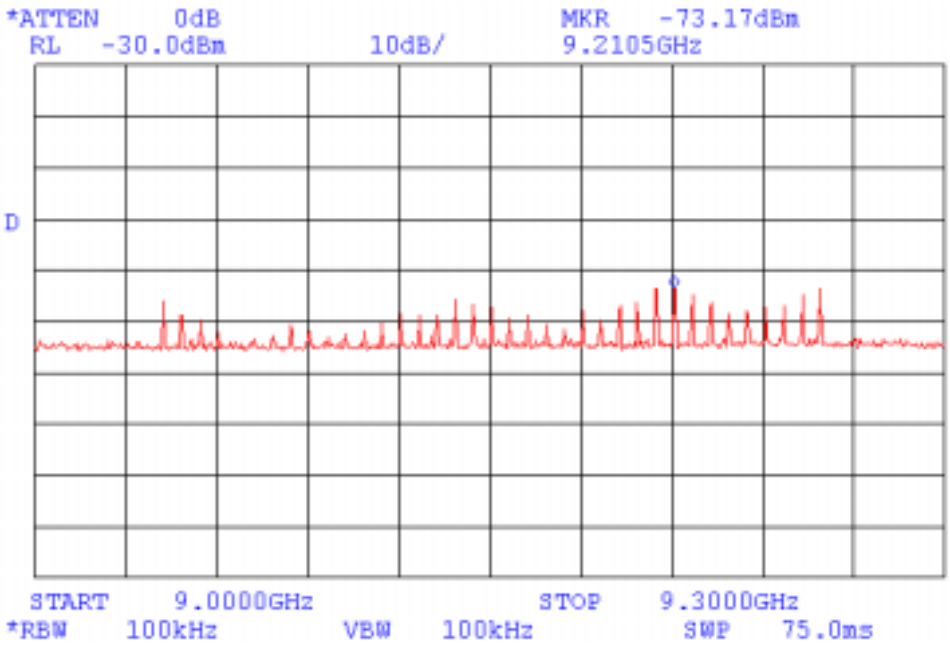
Plot 4.5.16

Test specification: § 15.247 (c)
Out-of-band emissions at the antenna output terminal
The 10th harmonic of carrier



No external attenuation

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4.6 Out of band radiated emissions test according to §15.247(c) and § 15.205, §15.209(a)

4.6.1 General

This test was performed to measure radiated emissions generated by the transmitter which fall in the restricted bands and to prove that they comply with §15.209(a) limits.

4.6.2 Test procedure

4.6.2.1 The radiated emissions measurements were performed in the anechoic chamber with loop and biconilog antennas from 9 kHz to 1730 MHz and at open field test site with double ridged guide antenna from 1 GHz to 10 GHz at 3 meters test distance as shown in Figure 4.6.1 and Photographs 4.6.1, 4.6.2.

4.6.2.2 The EUT was set up on the wooden turntable. To find the maximum radiation measuring antenna height was changed from 1 to 4 m, the turntable was rotated 360° and the antennas polarization was changed from vertical to horizontal.

4.6.2.3 The test was performed with transmitter operating at central frequency in 9 kHz to 30 MHz frequency range, at the lowest and the highest frequencies in 30 MHz to 1730 MHz range and at 3 carrier frequencies F_{max} = 925.8 MHz, F_{min} = 904.2 MHz, F_{cent} = 915 MHz in 1 GHz to 9.5 GHz range.

4.6.2.4 Test results are recorded in Tables 4.6.1 to 4.6.3 and shown in Plots 4.6.1 to 4.6.12.

4.6.2.5 The EUT was found to be in compliance with the standard requirements and passed the test.

Reference numbers of test equipment used

HL 0038	HL 0041	HL 0465	HL 0521	HL 0554	HL 0604	HL 1175	HL 1424

Full description is given in Appendix A.

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Table 4.6.1 Radiated emission measurements test results,
F carrier = 904.2 MHz

TEST SPECIFICATION: FCC part 15 subpart C § 15.247(c) 15.209(a)
DATE: March 28, 2001
Relative Humidity: 50%
Ambient Temperature: 25°C
Test distance 3 m
Detector type PEAK, AVERAGE
Resolution bandwidth 1 MHz

Peak detector, RBW = VBW = 1 MHz

Freq., GHz	Antenna polar.	Measured result, dB (μV)	Antenna factor, dB (1/m)	Cable loss, dB	Amplifier gain, dB	Radiated emission, dB (μV/m)	Limit, dB(μV/m)	Margin, dB	Pass/ Fail
2712.6	V	49.1	29.5	2	20	60.6	74	13.4	Pass
3616.8	H	43.8	31.6	2.75	20	57.65	74	16.35	Pass
4521.0	H	49.8	32.2	2.3	20	64.3	74	9.7	Pass
5425.2	V	40.7	34.5	2.78	20	57.98	74	16.0	Pass

Average detector, RBW = 1 MHz; VBW = 10 Hz

Freq., GHz	Antenna polar.	Measured result, dB (μV)	Antenna factor, dB (1/m)	Cable loss, dB	Amplifier gain, dB	Radiated emission, dB (μV/m)	Limit, dB(μV/m)	Margin, dB	Pass/ Fail
2712.6	V	39.1	29.5	2	20	50.6	54	3.4	Pass
3616.8	H	32.5	31.6	2.75	20	46.35	54	7.65	Pass
4521.0	H	33.4	32.2	2.3	20	47.9	54	6.1	Pass
5425.2	V	27.1	34.5	2.78	20	44.38	54	9.6	Pass

Notes to table:
Measurements were performed with double ridged guide antenna.

Table abbreviations:
Margin = dB below (negative if above) specification limit.
RBW = resolution bandwidth;
VBW = video bandwidth.

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Table 4.6.2 Radiated emission measurements test results,
F carrier = 915 MHz

TEST SPECIFICATION: FCC part 15 subpart C § 15.247(c) 15.209(a)
DATE: March 28, 2001
Relative Humidity: 50%
Ambient Temperature: 25°C
Test distance 3 m
Detector type PEAK, AVERAGE
Resolution bandwidth 1 MHz

Peak detector, RBW = VBW = 1 MHz

Freq., GHz	Antenna polar.	Measured result, dB (μV)	Antenna factor, dB (1/m)	Cable loss, dB	Amplifier gain, dB	Radiated emission, dB (μV/m)	Limit, dB(μV/m)	Margin, dB	Pass/ Fail
2745	V	49.9	29.5	2	20	61.4	74	12.6	Pass
3660	H	45.3	31.6	2.25	20	59.15	74	14.85	Pass
4575	H	43.3	32.2	1.5	20	57.0	74	17	Pass
7320	V	37.6	35.7	1.8	20	55.1	74	18.9	Pass
8235	H	35.9	37	1.8	20	54.7	74	19.3	Pass
9150	H	35.5	37.7	2.0	20	55.2	74	18.8	Pass

Average detector, RBW = 1 MHz; VBW = 10 Hz

Freq., GHz	Antenna polar.	Measured result, dB (μV)	Antenna factor, dB (1/m)	Cable loss, dB	Amplifier gain, dB	Radiated emission, dB (μV/m)	Limit, dB(μV/m)	Margin, dB	Pass/ Fail
2745	V	39.4	29.5	2	20	50.9	54	3.1	Pass
3660	H	34.3	31.6	2.25	20	48.15	54	5.85	Pass
4575	H	34.3	32.2	1.5	20	48.0	54	6	Pass
7320	V	26.9	35.7	1.8	20	44.4	54	9.6	Pass
8235	H	21.4	37	1.8	20	40.2	54	13.8	Pass
9150	H	21.4	37.7	2.0	20	41.1	54	12.9	Pass

Notes to table:
Measurements were performed with double ridged guide antenna.

Table abbreviations:
Margin = dB below (negative if above) specification limit.
RBW = resolution bandwidth;
VBW = video bandwidth.

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Table 4.6.3 Radiated emission measurements test results,
F carrier = 925.8 MHz

TEST SPECIFICATION: FCC part 15 subpart C § 15.247(c) 15.209(a)
DATE: March 28, 2001
Relative Humidity: 50%
Ambient Temperature: 25°C
Test distance 3 m
Detector type PEAK, AVERAGE
Resolution bandwidth 1 MHz

Peak detector, RBW = VBW = 1 MHz

Freq., GHz	Measured result, dB (µV)	Antenna factor, dB (1/m)	Cable loss, dB	Amplifier gain, dB	Radiated emission, dB (µV/m)	Limit, dB(µV/m)	Margin, dB	Pass/ Fail
2777.4	50.3	31.1	1.3	20	62.7	74	11.3	Pass
3703.2	40.1	33	1.4	20	54.5	74	19.5	Pass
4629	39.4	36.3	1.5	20	53.8	74	20.2	Pass
7406.4	36.9	41.2	1.7	20	59.8	74	14.2	Pass
8332.2	36.1	40.7	1.8	20	58.7	74	15.3	Pass

Average detector, RBW = 1 MHz; VBW = 10 Hz

Freq., GHz	Measured result, dB (µV)	Antenna factor, dB (1/m)	Cable loss, dB	Amplifier gain, dB	Radiated emission, dB (µV/m)	Limit, dB(µV/m)	Margin, dB	Pass/ Fail
2777.4	39.1	31.1	1.3	20	51.5	54	2.5	Pass
3703.2	29.8	33	1.4	20	44.2	54	9.8	Pass
4629	29.1	36.3	1.5	20	46.9	54	7.1	Pass
7406.4	25.6	41.2	1.7	20	48.5	54	5.5	Pass
8332.2	22.3	40.7	1.8	20	44.9	54	9.1	Pass

Notes to table:
Measurements were performed with double ridged guide antenna in horizontal polarization, peak detector was used, resolution bandwidth = 1 MHz, video bandwidth = 1 MHz.

Table abbreviations:
Margin = dB below (negative if above) specification limit.
RBW = resolution bandwidth;
VBW = video bandwidth.

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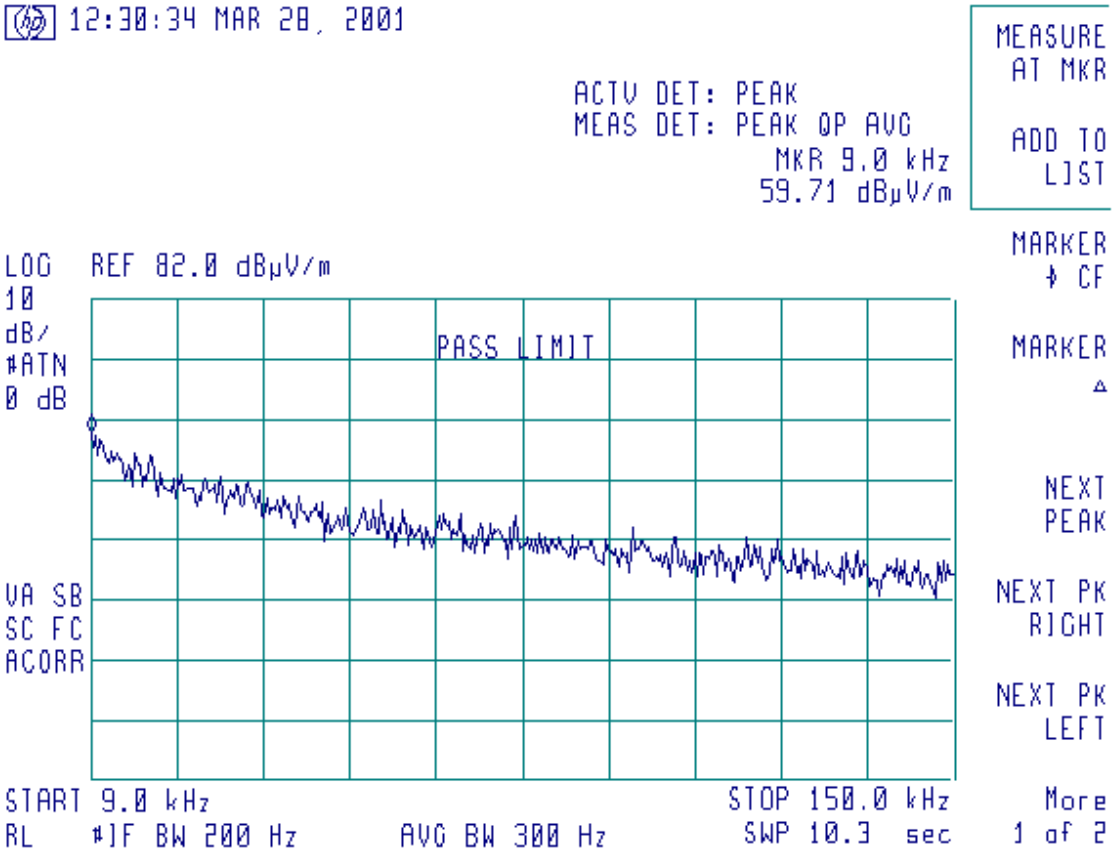
Plot 4.6.1 Radiated spurious emissions test results

9 kHz to 150 kHz frequency range



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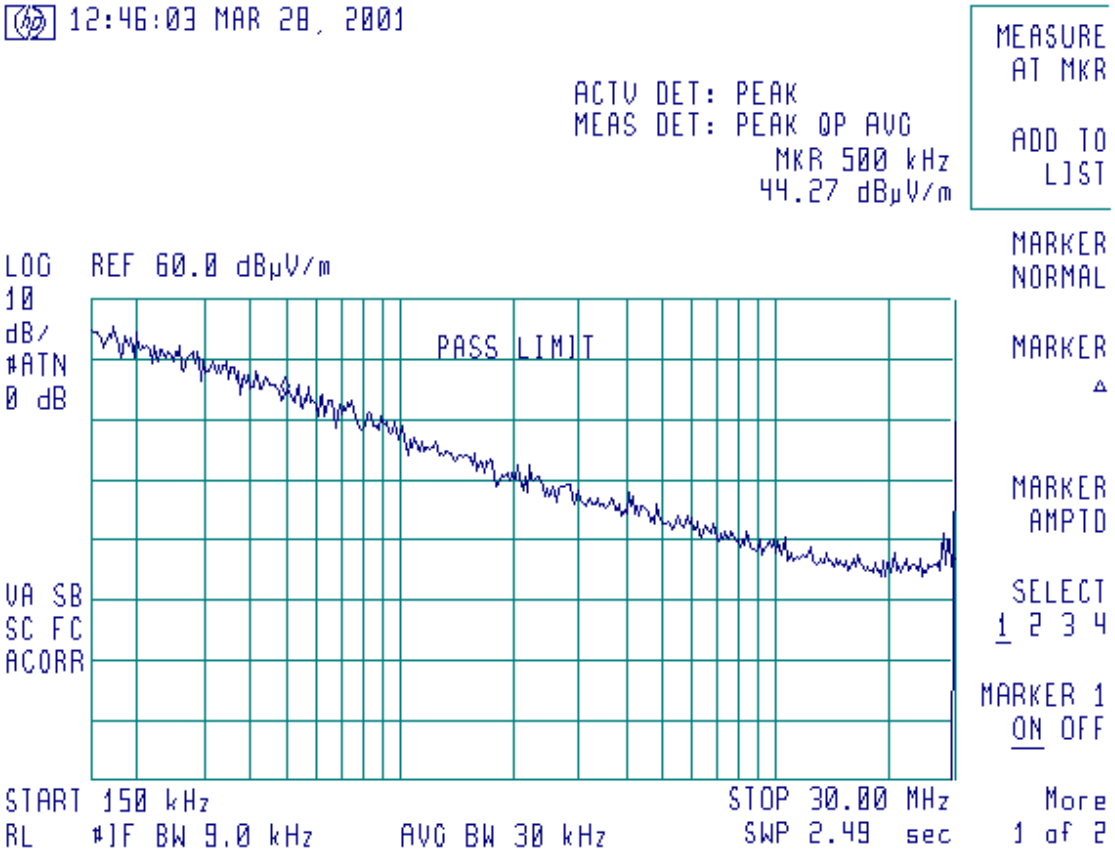
Plot 4.6.2 Radiated spurious emissions test results

150 kHz to 30 MHz frequency range



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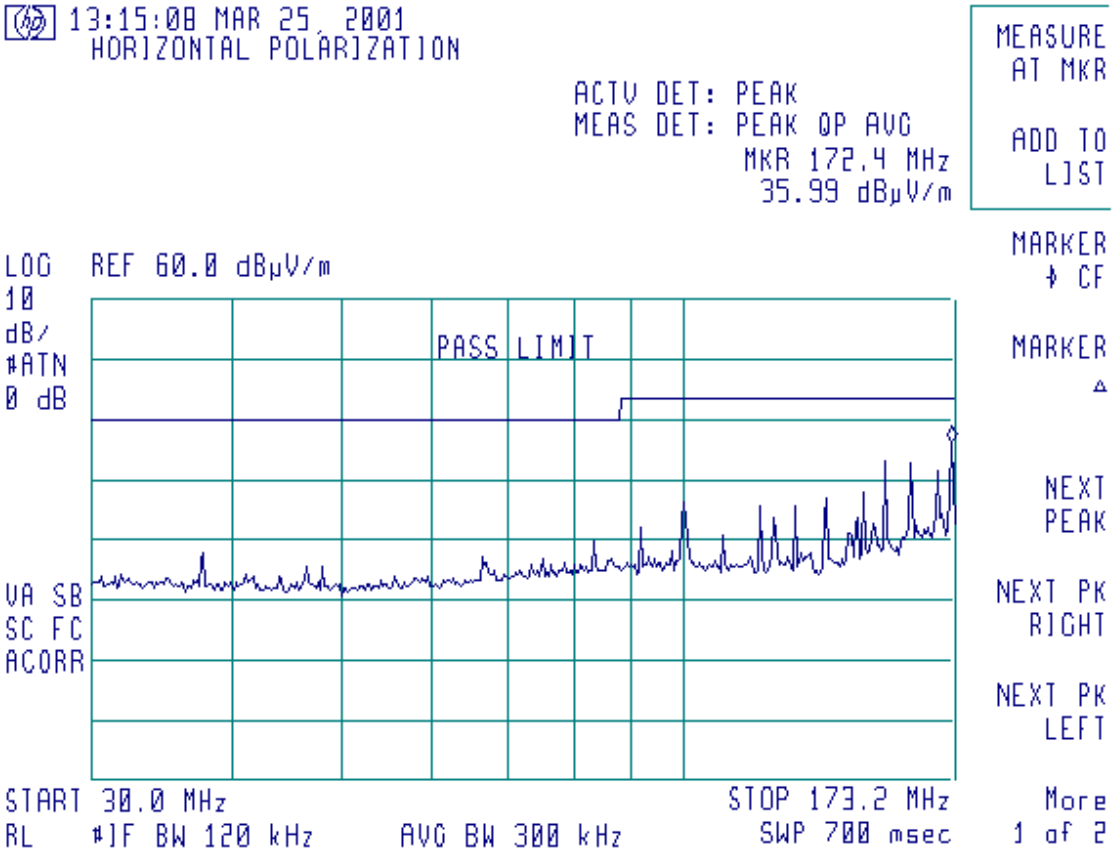
Plot 4.6.3 Radiated spurious emissions test results, F_{min} = 904,2 MHz

30 MHz to 173 MHz frequency range



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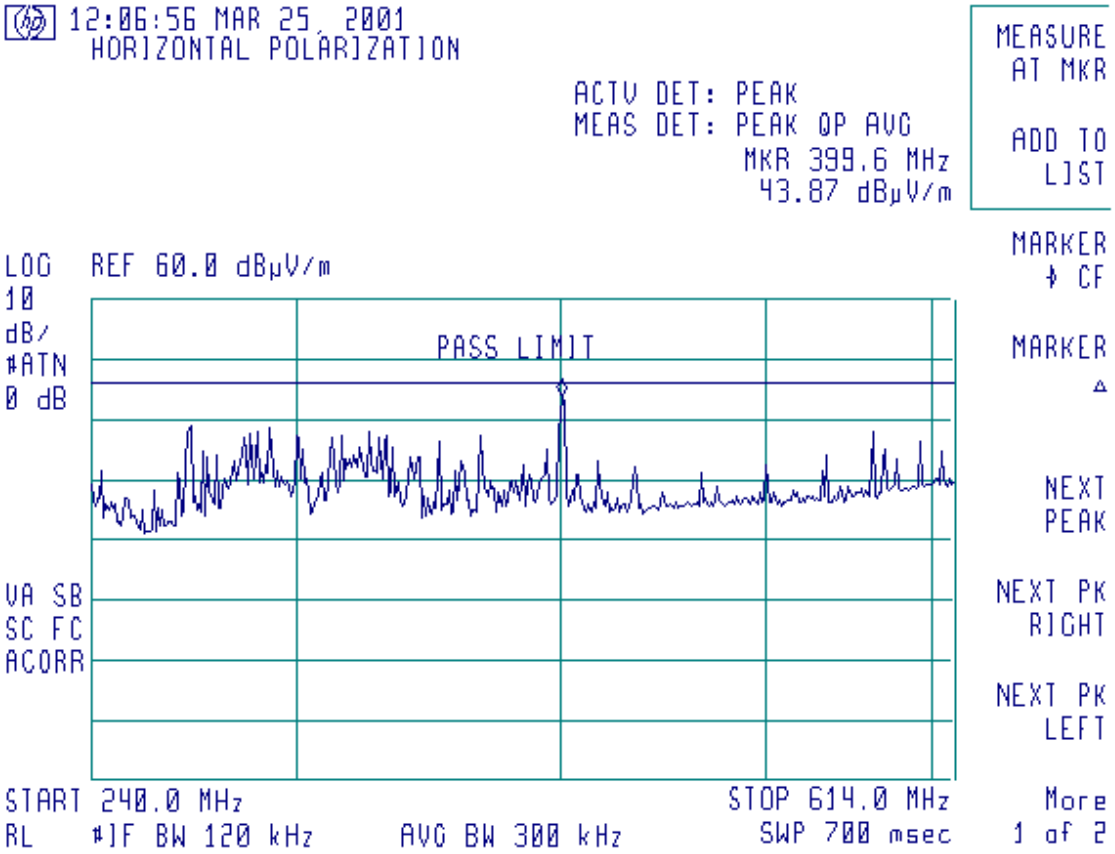
Plot 4.6.4 Radiated spurious emissions test results, F_{min} = 904,2 MHz

240 MHz to 614 MHz frequency range



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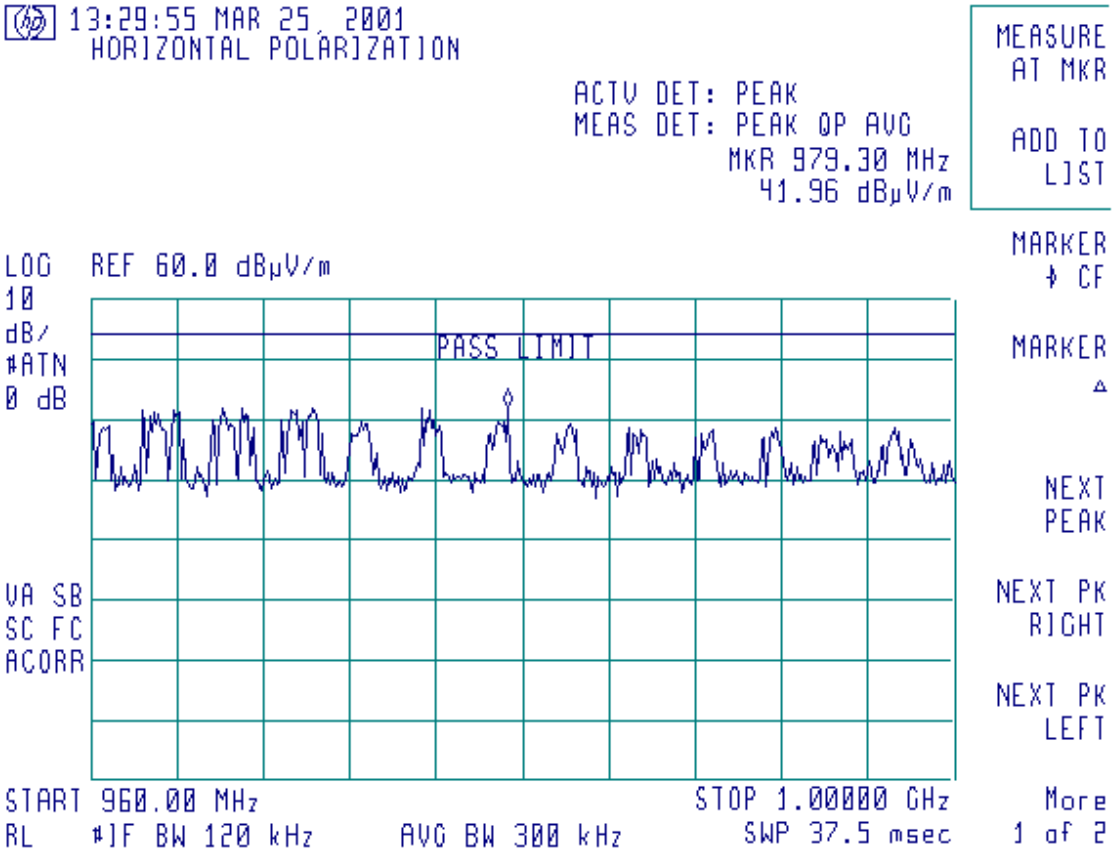
Plot 4.6.5 Radiated spurious emissions test results, F_{min} = 904,2 MHz

960 MHz to 1000 MHz frequency range



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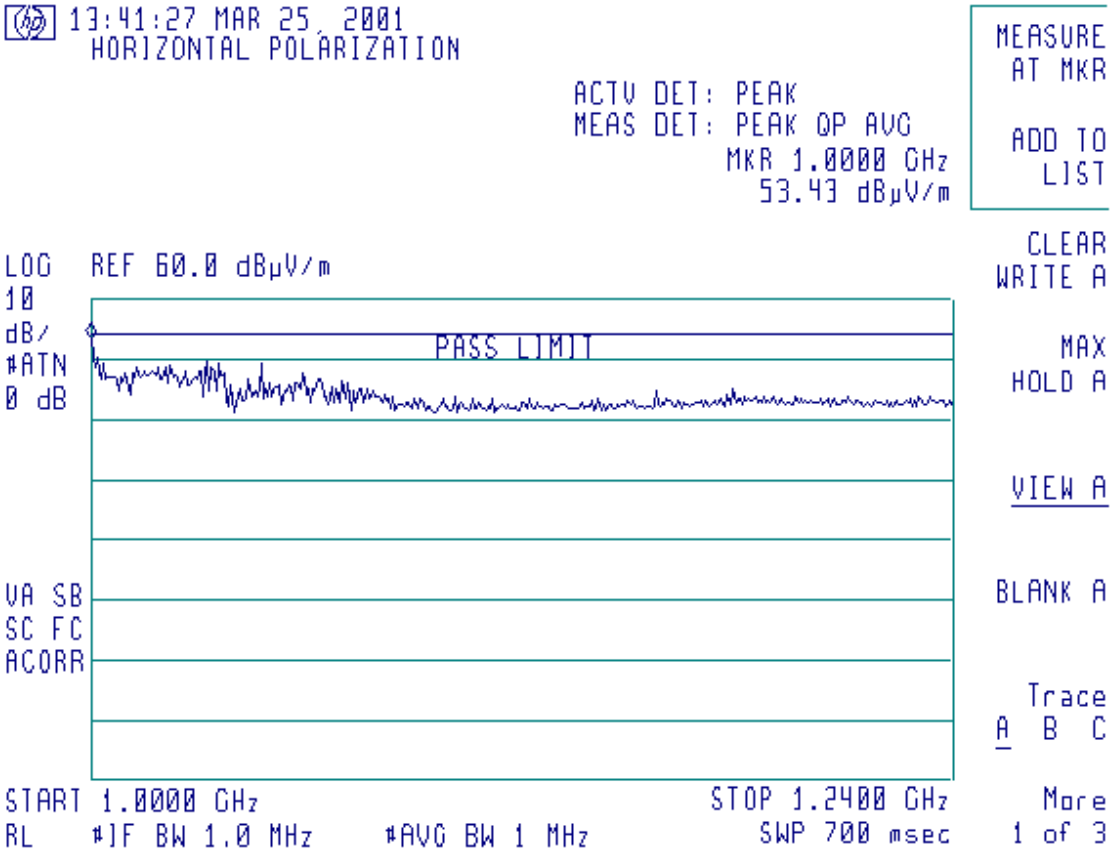
Plot 4.6.6 Radiated spurious emissions test results, F_{min} = 904,2 MHz

1000 MHz to 1240 MHz frequency range



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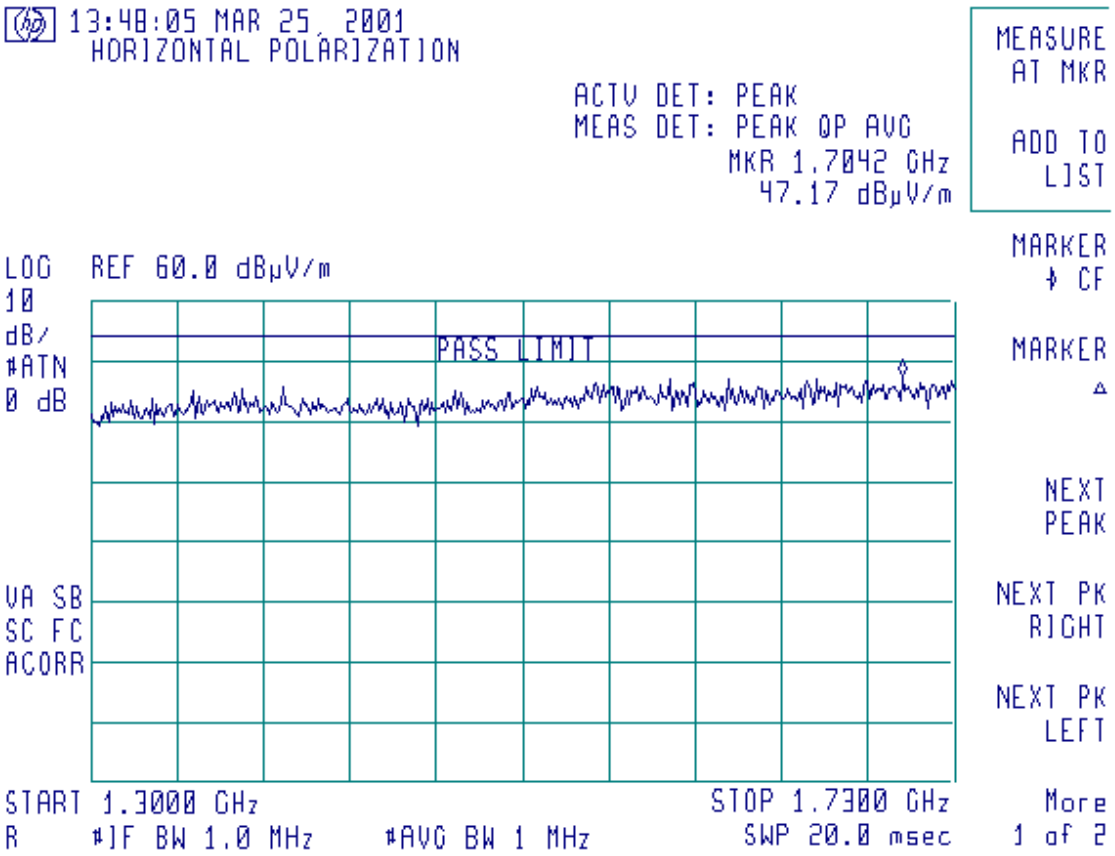
Plot 4.6.7 Radiated spurious emissions test results, F_{min} = 904,2 MHz

1300 MHz to 1730 MHz frequency range



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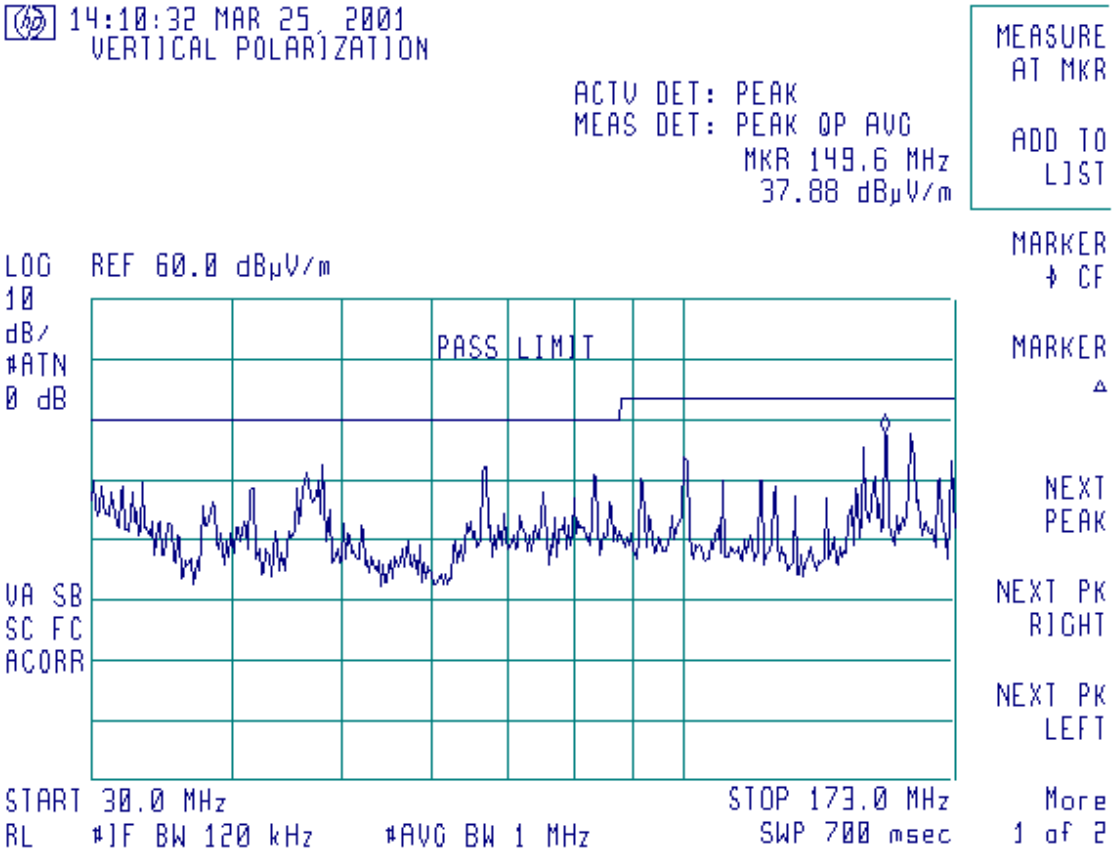
Plot 4.6.8 Radiated spurious emissions test results, F_{max} = 925.8 MHz

30 MHz to 173 MHz frequency range



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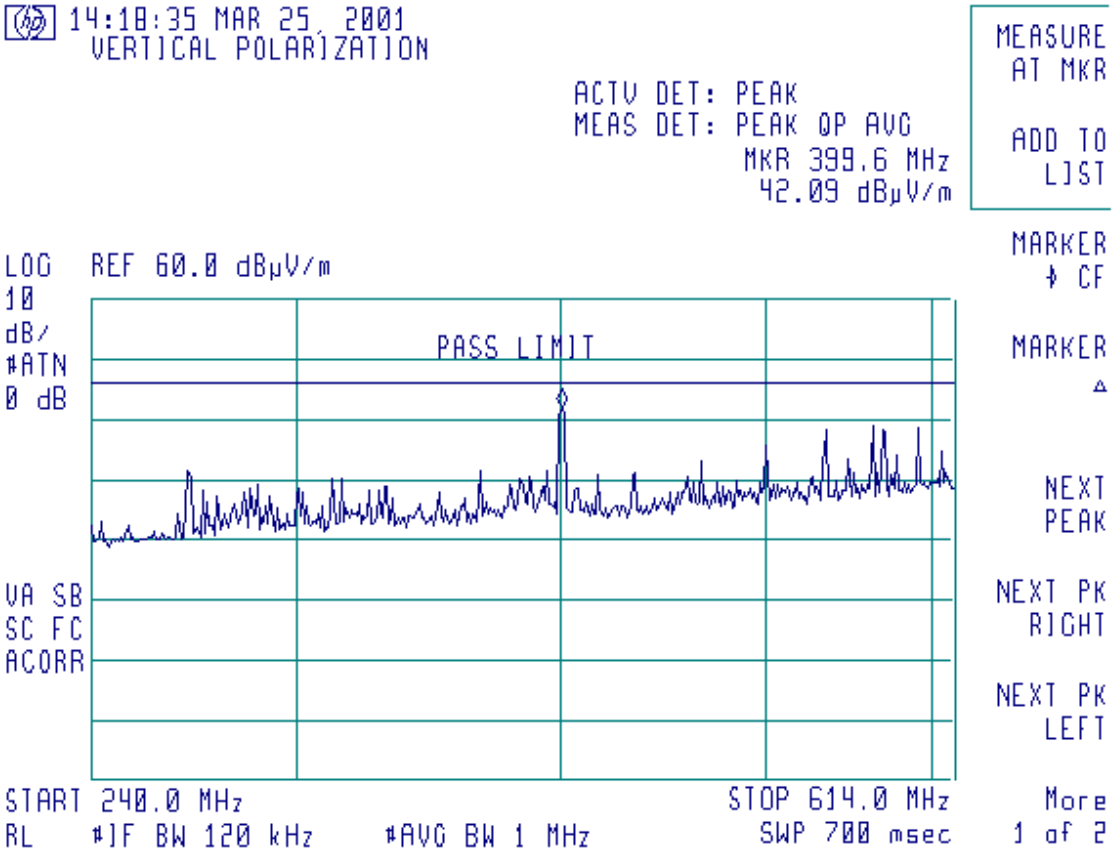
Plot 4.6.9 Radiated spurious emissions test results, F_{max} = 925.8 MHz

240 MHz to 614 MHz frequency range



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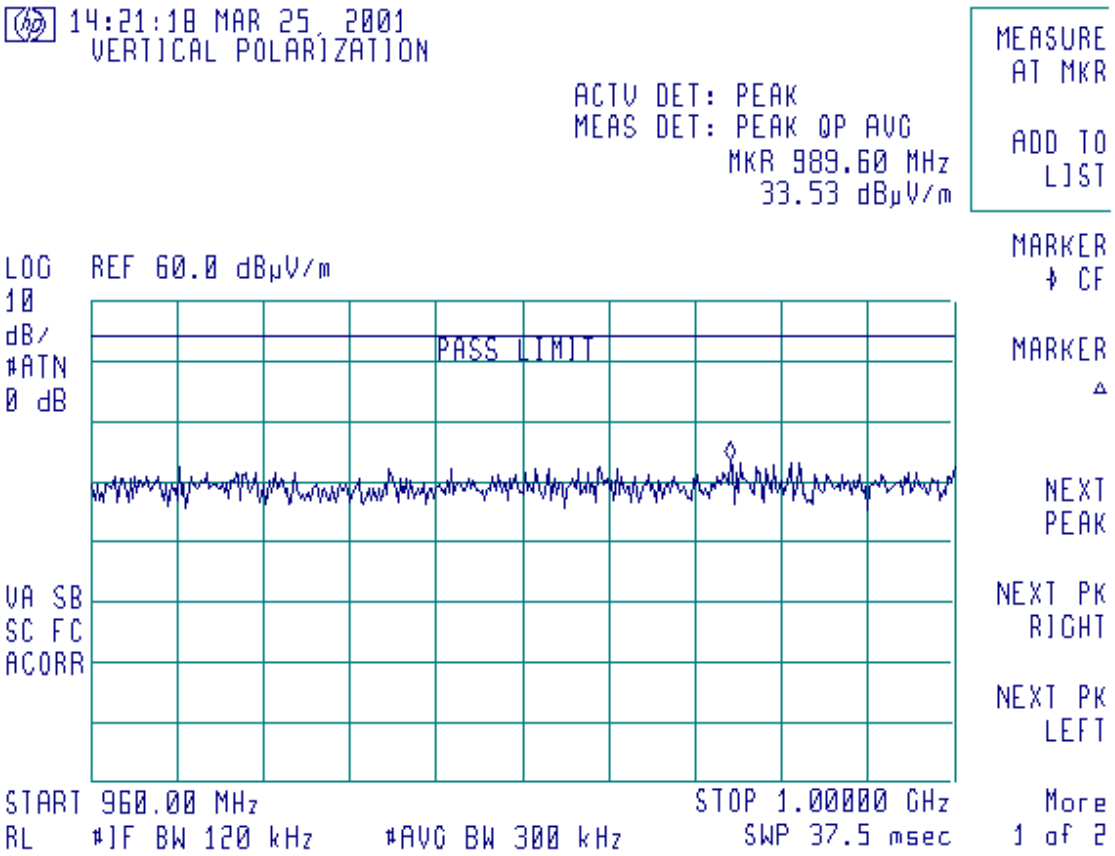
Plot 4.6.10 Radiated spurious emissions test results, F_{max} = 925.8 MHz

960 MHz to 1000 MHz frequency range



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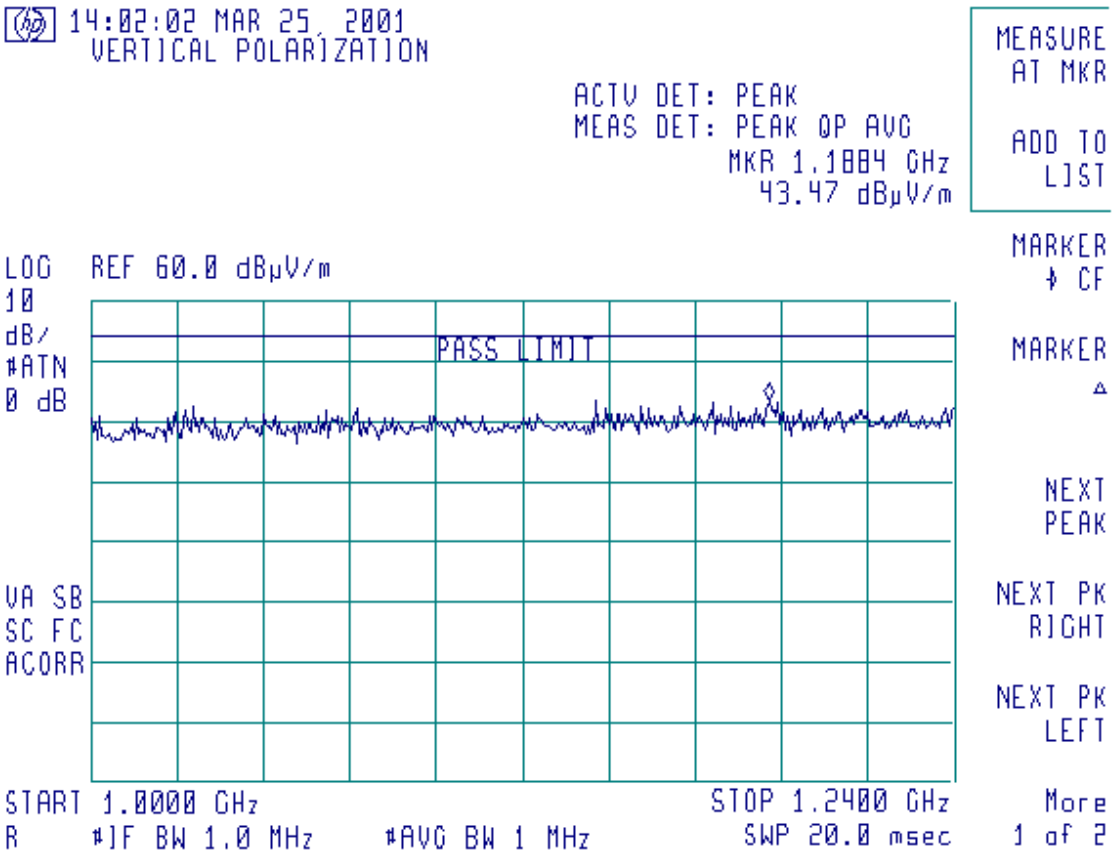
Plot 4.6.11 Radiated spurious emissions test results, F_{max} = 925.8 MHz

1000 MHz to 1240 MHz frequency range



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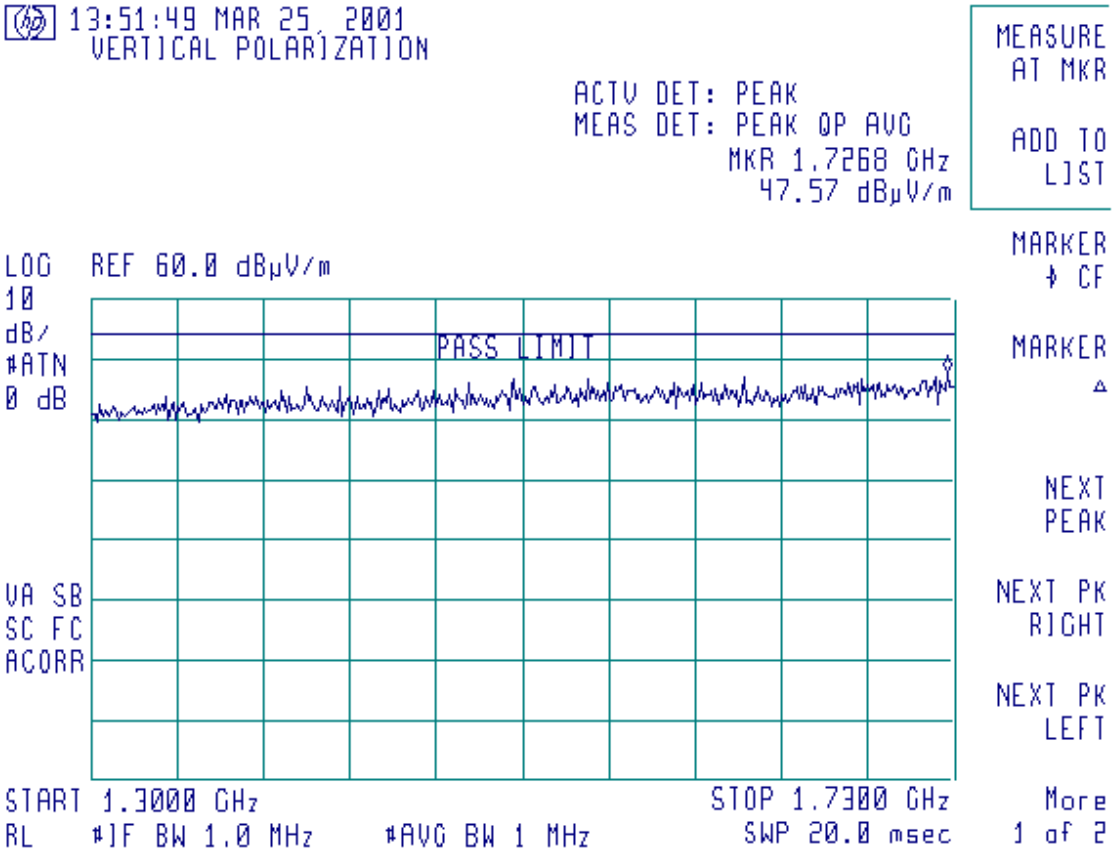
Plot 4.6.12 Radiated spurious emissions test results, F_{max} = 925.8 MHz

1300 MHz to 1730 MHz frequency range



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Photograph 4.6.1 Radiated emission measurement test setup

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4.7 Unintentional conducted emissions (class B digital device) test according to §15.107, 15.207

4.7.1 General

Conducted emission measurements specification limits are given in Table 4.7.1 below.

Table 4.7.1 Mains terminal radio interference voltage specification limits

Frequency, MHz	Class B Equipment, dB(μV)
0.45 – 30	48

4.7.2 Test procedure

4.7.2.1 The EUT was set up as shown in Figure 4.7.1 and associated photographs, energized and the performance check was conducted.

4.7.2.2 The measurements were performed at mains terminals by means of LISN, connected to spectrum analyzer in the frequency range referred to in Table 4.7.1. The unused coaxial connector of the LISN was terminated with 50 Ω. The measurements were made with quasi-peak detector as referred to in Table 4.7.2.

4.7.2.3 The position of the EUT cables was varied to determine maximum emission level.

4.7.2.4 The EUT was found to be in compliance with the standard requirements and passed the test.

Reference numbers of test equipment used

HL 0163	HL 0787	HL 1425	HL 1566

Full description is given in Appendix A.

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Table 4.7.2 Conducted emission measurements test results

TEST SPECIFICATION:	FCC part 15, class B
DATE:	March 27, 2001
RELATIVE HUMIDITY:	51%
AMBIENT TEMPERATURE:	23°C
THE EUT WAS TESTED AS:	TABLE-TOP
DETECTOR USED:	QUASI-PEAK
FREQUECNY RANGE:	450 kHz – 30 MHz
RESOLUTION BANDWIDTH:	9 kHz

Phase

Frequency, MHz	Measured emissions, peak detector, dB (µV)	Measured emissions, quasi-peak detector, dB (µV)	Specification limit, dB (µV)	Margin, dB	Pass/ Fail
0.479545	53.36	46.71	48	1.29	**Pass**
0.509640	50.80	44.53	48	3.47	**Pass**
0.518828	50.07	43.73	48	4.27	**Pass**
2.351810	43.12	38.55	48	9.45	**Pass**

The "Pass" decision was made without Hermon Labs uncertainty.

Table calculations and abbreviations:

- Measured conducted emissions = EMI meter reading (dBµV) + cable loss (dB) + LISN correction factor (dB). (For LISN correction factor refer to Appendix B).
- Margin = dB below (negative if above) specification limit.

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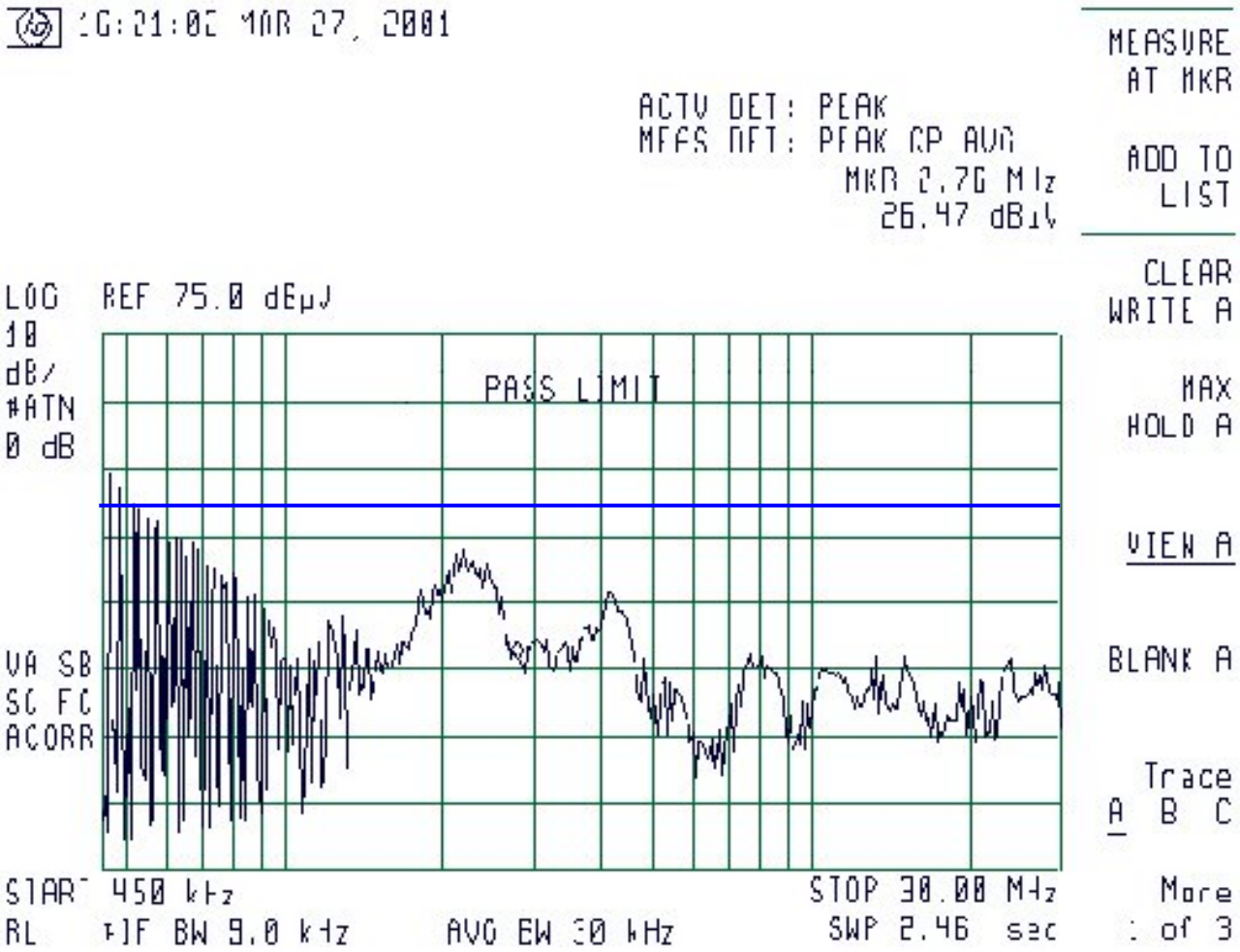
Plot 4.7.1 Conducted emission measurements test results

LINE: PHASE
LIMIT: QUASI-PEAK
DETECTOR: PEAK



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Plot 4.7.2 Conducted emission measurements test results

LINE: NEUTRAL
LIMIT: QUASI-PEAK
DETECTOR: PEAK

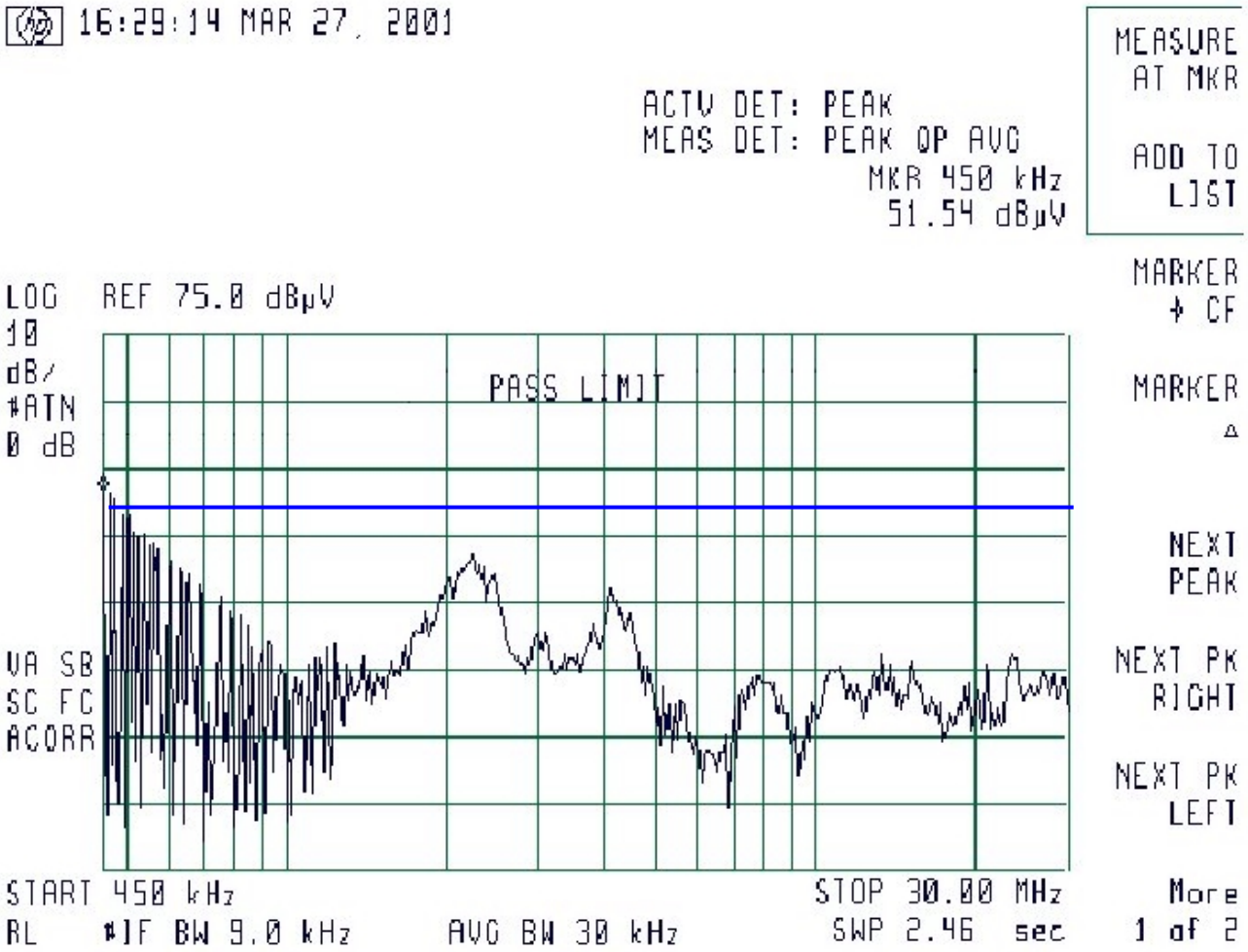

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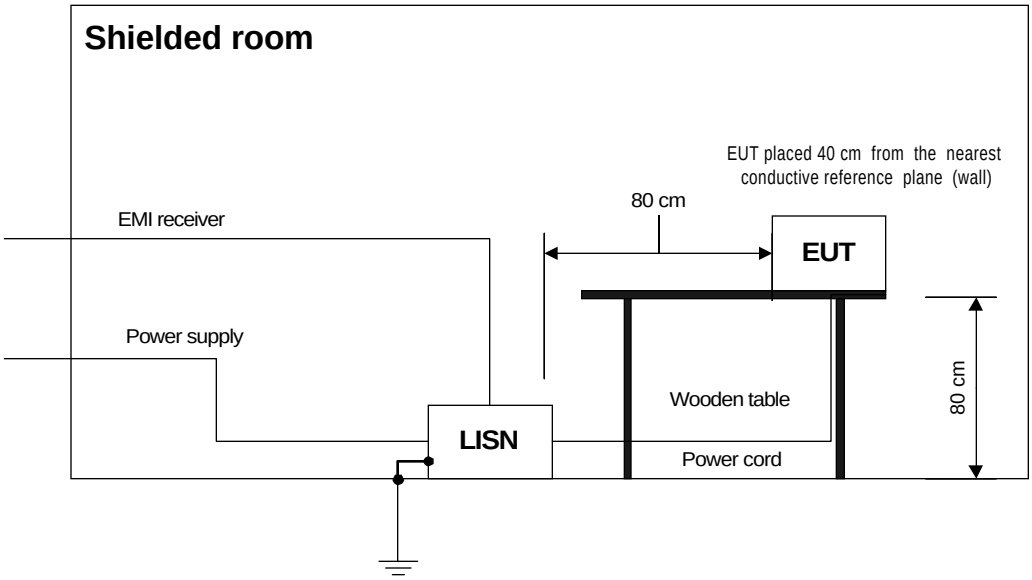
Figure 4.7.1 Setup for conducted emission test, table-top equipment



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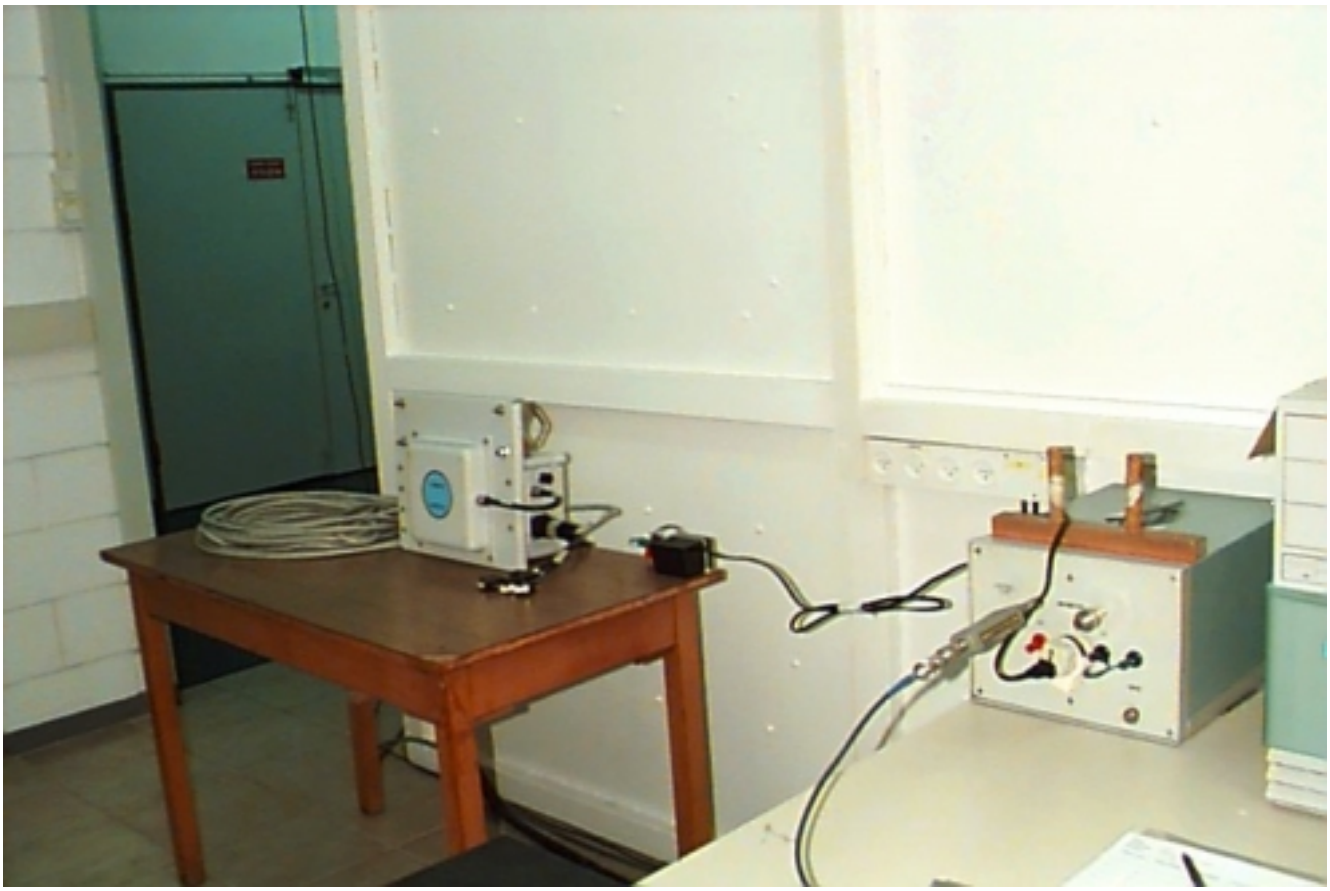
Photograph 4.7.1 Setup for conducted emission test



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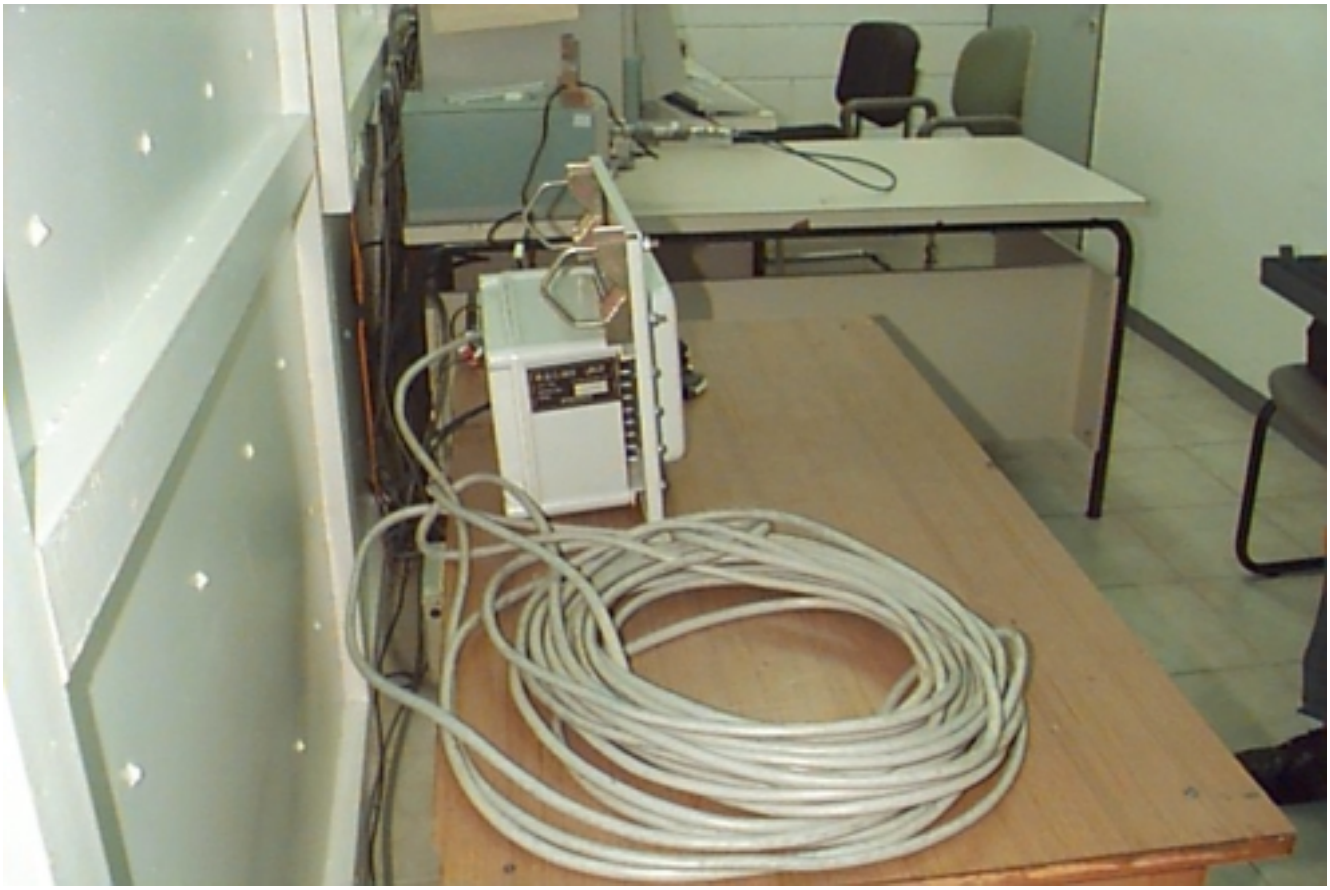
Photograph 4.7.2 Setup for conducted emission test



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4.8 Unintentional radiated emissions (class A digital device) test according to §15.109, 15.209

4.8.1 General

This test was performed to measure radiated emissions from the EUT enclosure. Specification test limits are given in Table 4.8.1. The worst test results (lowest margin) were recorded in Table 4.8.2.

Table 4.8.1 Limits for electric field strength, quasi-peak detector, 10 m distance

Frequency, MHz	Class A equipment dB(μV/m)
30 - 88	39.0
88 - 216	43.5
216 - 960	46.4
960 - 5000	49.5

• As the highest frequency used in the device was 14 MHz (less than 108 MHz), the measurements were performed in the frequency range 30 – 1000 MHz.

4.8.2 Test procedure

4.8.2.1 The EUT was set up as shown in Figure 4.8.1 and associated photographs, energized and the performance check was conducted.

4.8.2.2 The frequency range 30 MHz – 1000 MHz was investigated by means of biconical and log periodic antennas connected to EMI receiver.

4.8.2.3 To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was changed from 1 to 4 m, its polarization was changed from vertical to horizontal and the cables were moved.

4.8.2.4 The EUT was found to be in compliance with the standard requirements and passed the test.

Reference numbers of test equipment used

HL 0032	HL 0034	HL 0038	HL 0812	HL 0813	HL 1430

Full description is given in Appendix A.

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Table 4.8.2 Radiated emission measurements test results

TEST SPECIFICATION:	FCC part 15, Class A
DATE:	March 27, 2001
RELATIVE HUMIDITY:	51%
AMBIENT TEMPERATURE:	23°C
TEST PERFROMED IN:	OATS
DISTANCE BETWEEN ANTENNA AND EUT:	10 m
THE EUT WAS TESTED AS:	TABLE-TOP
FREQUECNY RANGE:	30 MHz – 1 GHz
DETECTOR TYPE:	QUASI-PEAK
RESOLUTION BANDWIDTH:	120 kHz
ANTENNA TYPE:	BICONICAL; LOG PERIODIC

Frequency, MHz	Ant. pol.	Ant. hgt., m	TT pos., (^{o})	Radiated emissions, dB (μV/m)	Specification limit, dB (μV/m)	Margin, dB	Pass/ Fail
66.82	V	1.0	100°	24.96	39	14.04	**Pass**
80.182	V	1.8	-20	24.22	39	14.78	**Pass**
367.49	H	2.2	-50	36.30	46.4	10.10	**Pass**
384.22	H	1.6	303	31.06	46.4	15.34	**Pass**
400.92	H	2.0	-38	34.07	46.4	12.33	**Pass**

Table calculations and abbreviations:

Radiated emission dB(μV/m) = measured results dB(μV) + correction factor dB(1/m).
Correction factor = antenna factor + cable loss (for antenna factor and cable loss refer to Appendix B).
Ant. pol = antenna polarization (V – vertical, H – horizontal).
Ant. hgt. = antenna height.
TT pos. = turntable position in degrees, (EUT front panel = 0^o).
Margin = dB below (negative if above) specification limit.

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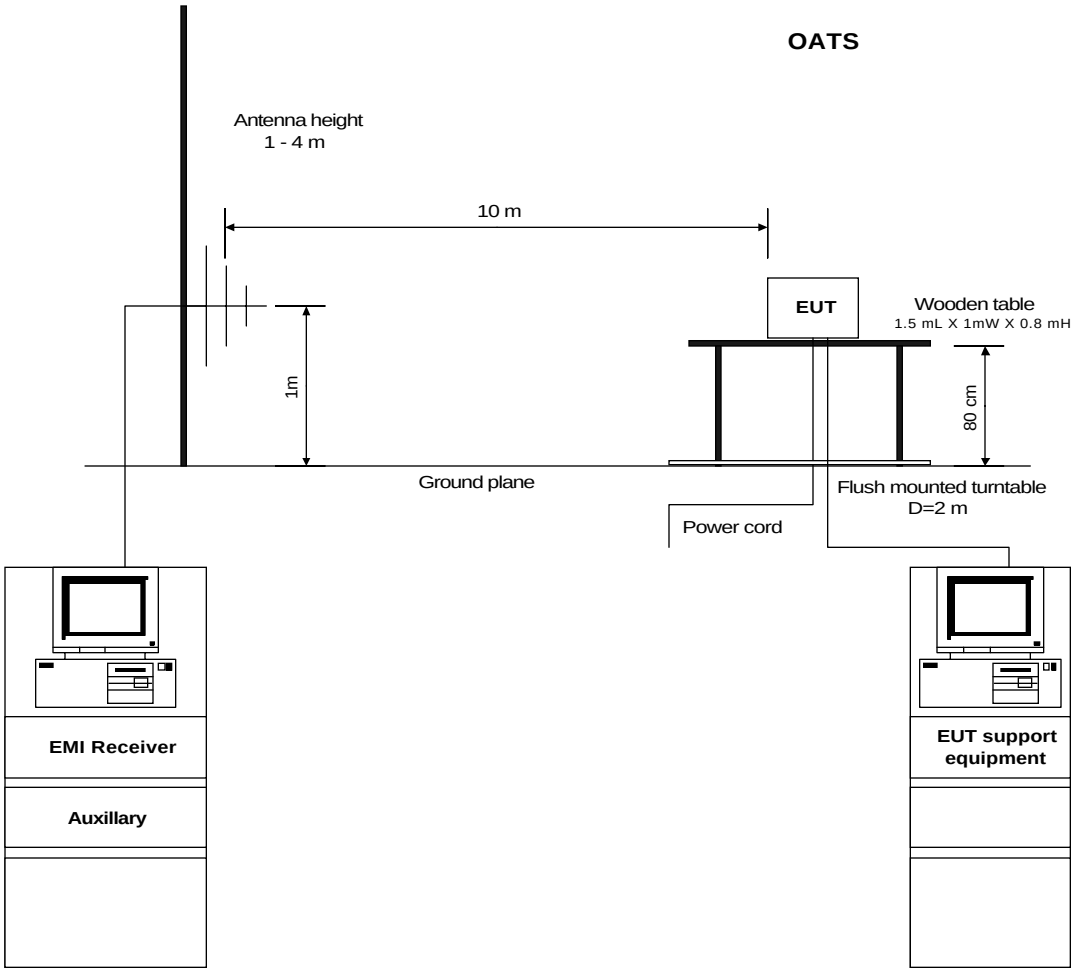
Figure 4.8.1 Setup for radiated emissions test performed in OATS, table-top equipment



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Photograph 4.8.1 Setup for radiated emission measurements

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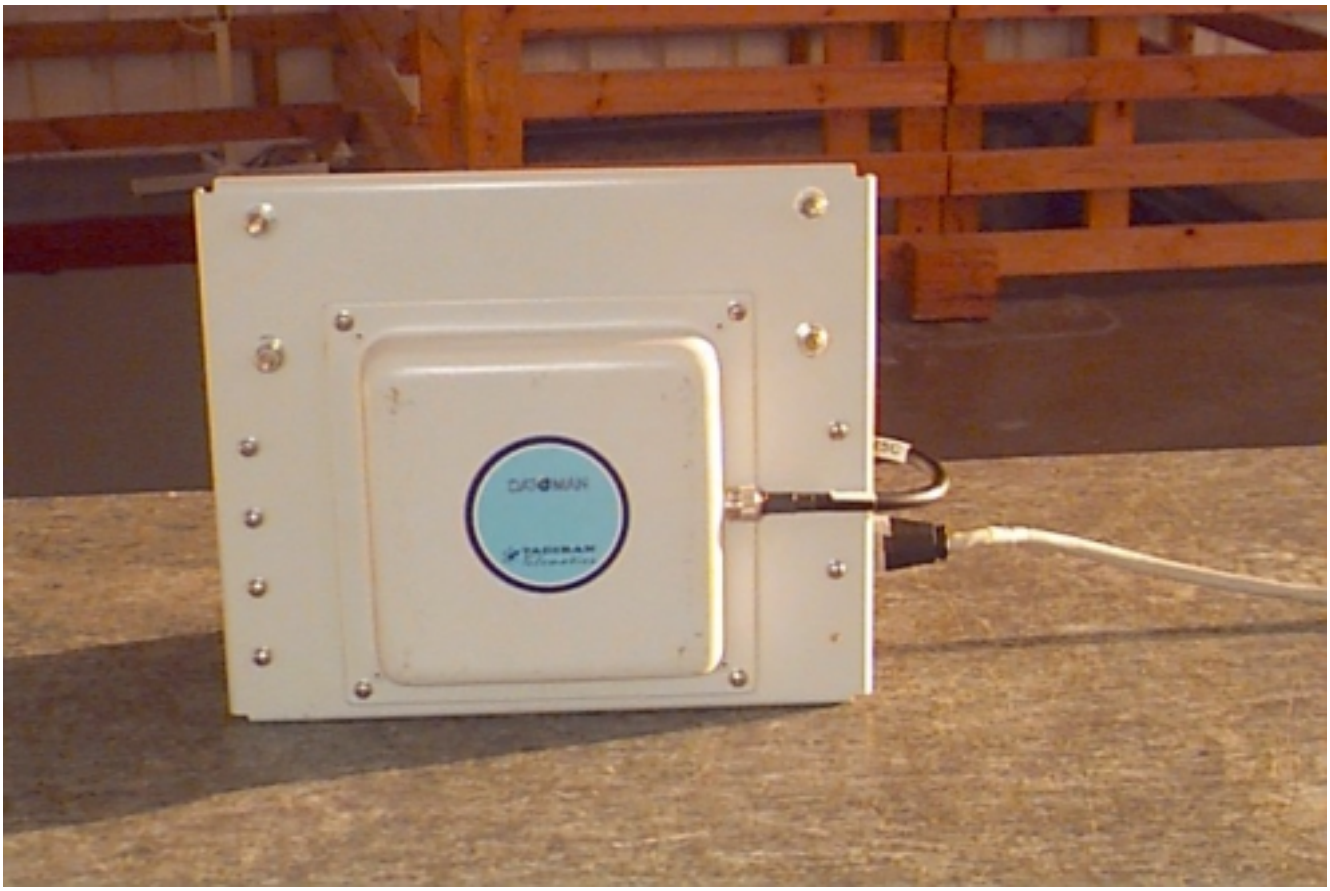
Photograph 4.8.2 Setup for radiated emission measurements



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APPENDIX A – Measurement uncertainty, test equipment and ancillaries used for tests

The test equipment has been calibrated according to its recommended procedures and is within the manufacturer's published limit of error. The standards and instruments used in the calibration system conform to the present requirements of ISO/IEC 17025 (or alternately through July 2002 ISO/IEC Guide 25 and /or ANSI/NCSL Z540-1).

The laboratory calibrates its standards by a third party (traceable to NIST, USA) on a regular basis according to equipment manufacturer requirements. The Hermon Labs EMC measurements uncertainty is given in Table below.

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Conducted emissions with LISN and HP 8542E/HP8546A receiver	▪ 9 kHz to 150 kHz: +2.43 dB/-2.22 dB ▪ 150 kHz to 30 MHz: + 2.22 dB/-2.05 dB
Radiated emissions in the open field test site at 10 m measuring distance	▪ Biconical antenna: +3.92 dB/-3.63 dB ▪ Log periodic antenna: +3.89 dB/-3.61 dB
Radiated emissions in the anechoic chamber at 3 m measuring distance	▪ Biconilog antenna: ±3.2 dB

Test equipment and ancillaries used for tests

HL Serial No.	Description	Manufacturer information			Due Calibr. Month/ year
		Name	Model No.	Serial No.	
0032	Biconical antenna, 20-200 MHz	Electro-Metrics	BIA-25/30	3577	01/02
0034	Log periodic antenna, 200 - 1000 MHz	Electro-Metrics	LPA 25/30	1988	01/02
0038	Antenna Mast, 1-4 m	Hermon Labs	AM-1	028	2/02 Check
0041	Double ridged guide antenna, 1-18 GHz	Electro-Metrics	RGA 50/60	2811	8/01
0163	LISN FCC/VDE/MIL -STD	Electro-Metrics	ANS-25/2	1314	10/01
0411	Cable, Coax, Microwave, DC-18 GHz, N-N, 2 m	Given Imaging	36Q01Q01078.8	9338768	9/01
0465	Anechoic Chamber 9 (L) x 6.5 (W) x 5.5 (H) m	Hermon Labs	AC-1	023	3/03
0521	Spectrum Analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz)	Hewlett Packard	8546A	0319	7/01
0554	Amplifier, 2 – 18 GHz RF	Miteq	AFD-4	4300	12/01
0604	Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz	EMCO	3141	9611-1011	12/00
0787	Transient limiter	Hewlett Packard	11947A-8ZE	A01877	11/01
0812	Cable, coax, RG-214, 11.5 m, N-type connectors	Hermon Labs	C214-11	148	8/01
0813	Cable, coax, RG-214, 12 m, N-type connectors	Hermon Labs	C214-12	149	8/01
0872	Cable coax	Amplifier Research	PFP01P010394	9338767	7/01
1175	Microwave 5 m cable	Gore	01C02245.2	NA	2/02
1424	Spectrum analyzer	Agilent Technologies	8564EC	0219	08/01

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HL Serial No.	Description	Manufacturer information			Due Calibr. Month/ year
		Name	Model No.	Serial No.	
1425	EMI receiver, 9 kHz – 2.9 GHz, System	Agilent Technologies	8542E	0222	09/01
1430	EMI receiver, 9 kHz – 2.9 GHz, System	Agilent Technologies	8542E	262,3	09/01

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APPENDIX B - Test equipment correction factors

Correction factor
Line impedance stabilization network
Model ANS-25/2
Electro-Metrics

Frequency, kHz	Correction Factor
10	4.9
15	2.86
20	1.83
25	1.25
30	0.91
35	0.69
40	0.53
50	0.35
60	0.25
70	0.18
80	0.14
90	0.11
100	0.09
125	0.06
150	0.04

The correction factor dB is to be added to the meter readings (dB/μv) of the interference analyzer or spectrum analyzer.

Antenna Factor
Double Ridged Guide Antenna
Model RGA-50/60, S/N 2811

Frequency, MHz	Antenna Factor, dB	Frequency, MHz	Antenna Factor, dB
1000	24.3	10000	38.2
1500	25.4	10500	38.5
2000	28.4	11000	39.0
2500	29.2	11500	40.1
3000	30.5	12000	40.2
3500	31.6	12500	39.3
4000	33.7	13000	39.9
4500	32.2	13500	40.6
5000	34.5	14000	41.1
5500	34.5	14500	40.5
6000	34.6	15000	39.9
6500	35.3	15500	37.8
7000	35.5	16000	39.1
7500	35.9	16500	41.1
8000	36.6	17000	41.7
8500	37.3	17500	45.1
9000	37.7	18000	44.3
9500	37.7		

Antenna factor is to be added to receiver meter reading in dB(μV) to convert to field intensity in dB(μV)/meter

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Antenna factor
Biconical antenna
Electro-Metrics, model BIA-25/30
Ser.No.3577

Frequency MHz	Antenna Factor dB(1/m)	Frequency MHz	Antenna Factor dB(1/m)
20	15.1	115	16.7
25	14.6	120	14.1
30	13.7	125	13.1
35	11.8	130	13.0
40	11.4	135	12.9
45	11.7	140	12.7
50	11.4	145	12.5
55	10.5	150	14.3
60	10.3	155	14.8
65	8.9	160	14.7
70	7.6	165	15.1
75	7.3	170	15.6
80	7.3	175	16.5
85	7.8	180	16.7
90	9.4	185	17.3
95	10.6	190	17.9
100	11.8	195	17.6
105	12.5	200	17.9
110	13.7		

Antenna factor is to be added to receiver meter reading in dB(µV) to convert to field intensity in dB(µV/meter).

Antenna factor
Log periodic antenna
Electro-Metrics, model LPA-25/30
Ser.No.1988

Frequency MHz	Antenna Factor dB(1/m)	Frequency MHz	Antenna Factor dB(1/m)
200	12.6	625	20.4
225	12.2	650	20.9
250	13.4	675	22.0
275	14.3	700	22.2
300	15.2	725	22.7
325	15.7	750	22.5
350	15.9	775	22.7
375	16.4	800	22.8
400	17.0	825	23.2
425	17.4	850	23.5
450	17.9	875	23.9
475	18.6	900	24.0
500	19.1	925	24.0
525	19.3	950	24.2
550	19.6	975	24.7
575	19.8	1000	25.1
600	20.0		

Antenna factor is to be added to receiver meter reading in dB(µV) to convert to field intensity in dB(µV/meter)

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Antenna factor
Biconilog antenna EMCO, model 3141
Ser.No.1011

Frequency, MHz	Antenna Factor, dB(1/m)	Frequency, MHz	Antenna Factor, dB(1/m)
26	7.8	940	24.0
28	7.8	960	24.1
30	7.8	980	24.5
40	7.2	1000	24.9
60	7.1	1020	25.0
70	8.5	1040	25.2
80	9.4	1060	25.4
90	9.8	1080	25.6
100	9.7	1100	25.7
110	9.3	1120	26.0
120	8.8	1140	26.4
130	8.7	1160	27.0
140	9.2	1180	27.0
150	9.8	1200	26.7
160	10.2	1220	26.5
170	10.4	1240	26.5
180	10.4	1260	26.5
190	10.3	1280	26.6
200	10.6	1300	27.0
220	11.6	1320	27.8
240	12.4	1340	28.3
260	12.8	1360	28.2
280	13.7	1380	27.9
300	14.7	1400	27.9
320	15.2	1420	27.9
340	15.4	1440	27.8
360	16.1	1460	27.8
380	16.4	1480	28.0
400	16.6	1500	28.5
420	16.7	1520	28.9
440	17.0	1540	29.6
460	17.7	1560	29.8
480	18.1	1580	29.6
500	18.5	1600	29.5
520	19.1	1620	29.3
540	19.5	1640	29.2
560	19.8	1660	29.4
580	20.6	1680	29.6
600	21.3	1700	29.8
620	21.5	1720	30.3
640	21.2	1740	30.8
660	21.4	1760	31.1
680	21.9	1780	31.0
700	22.2	1800	30.9
720	22.2	1820	30.7
740	22.1	1840	30.6
760	22.3	1860	30.6
780	22.6	1880	30.6
800	22.7	1900	30.6
820	22.9	1920	30.7
840	23.1	1940	30.9
860	23.4	1960	31.2
880	23.8	1980	31.6
900	24.1	2000	32.0
920	24.1		

Antenna factor is to be added to receiver meter reading in dB(μV) to convert to field intensity in dB(μV/meter)