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Electrical

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ELECTROMAGNETIC EMISSIONS TEST REPORT

according to 47CFR Part 15 subpart C, §15.247, and subpart B
for

Tadiran Telematics Ltd.

EQUIPMENT UNDER TEST:

TransMeter Water

Model: TMW-25U

Approved by: _____
Mr. Roman Sternberg, VP marketing
Tadiran Telematics Ltd.

Document ID: TADRAD_FCC_15503_rev1
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Contents

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1 Project information

Description of equipment under test

Test items	: TransMeter Water
Manufacturer	: Tadiran Telematics Ltd
Types (Models)	: TMW-25U
Equipment FCC code	: DSS

Applicant information

Applicant's responsible person	: Mr. Uzi Erman
Company	: Tadiran Telematics Ltd
Address	: 26, Hamelacha street
City	: Holon
Postal code	: 58117
Country	: Israel
Telephone number	: +972 3 557 5755
Telefax number	: +972 3 557 5753

Test performance

Project Number:	: 15503
Location	: Hermon Laboratories
Receipt date	: April 9, 2003
Test performed	: April 16, 2003
Purpose of test	: Apparatus compliance verification in accordance with emission requirements
Test specification(s)	47CFR Part 15 subpart C, §15.247, and subpart B

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2 Summary of tests

The tests listed in the table below were performed. The EUT was found complying with the limits of 47CFR Part 15 subpart C, §15.247, and subpart B.

Parameter	Subclause	C	NC	NT	NA	Tested by	Date tested	Remarks
Transmitter characteristics, §15.247								
Digitally modulated systems								
Minimum 6 dB bandwidth	a(2)	**C**				Mr. Y. Neuman, test engineer	April 9, 2003	
Maximum peak output power	b(3)	**C**				Mr. Y. Neuman, test engineer	April 9, 2003	
Exposure compliance requirements	b(4)	**C**						
Spurious emissions (conducted)	c	**C**				Mr. Y. Neuman, test engineer	April 9, 2003	
Spurious emissions (radiated)	c			NT				
Spurious emissions (radiated) in restricted bands	15.209, 15.205 (a, c)	**C**				Mr. Y. Neuman, test engineer Mrs. E. Pitt, test engineer	April 9, 2003 April 16, 2003	
Peak power spectral density	d	**C**				Mr. Y. Neuman, test engineer	June 19, 2003	
Unintentional radiation, §15.107, §15.109								
Conducted emissions	15.107				**NA**			
Radiated emissions	15.109	**C**				Mr. Y. Neuman, test engineer	April 9, 2003	

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General conditions under Part 15						
The intentional radiator operates in 902 MHz – 928 MHz	15.247	**C**				
The intentional radiator has permanently attached antenna or antenna that uses a unique coupling to the intentional radiator.	15.203	**C**				
No antenna other than that furnished by the responsible party can be used with the device.	15.203	**C**				
Antenna technical characteristics, as referred to in "Transmitter description" table in the test report	15.204	**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.						

Test report prepared by: Mrs. V. Mednikov, MSc., certification engineer

Test report approved by: Mr. E. Usoskin, PhD, CEO

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3 EUT description

3.1 General description

The EUT, TMW-25U, is a 2-way wireless RF transceiver which is attached to water meters.
The device consists of two parts: RF transceiver with integral antenna and a microcontroller, powered by two internal 3.6 V lithium batteries.

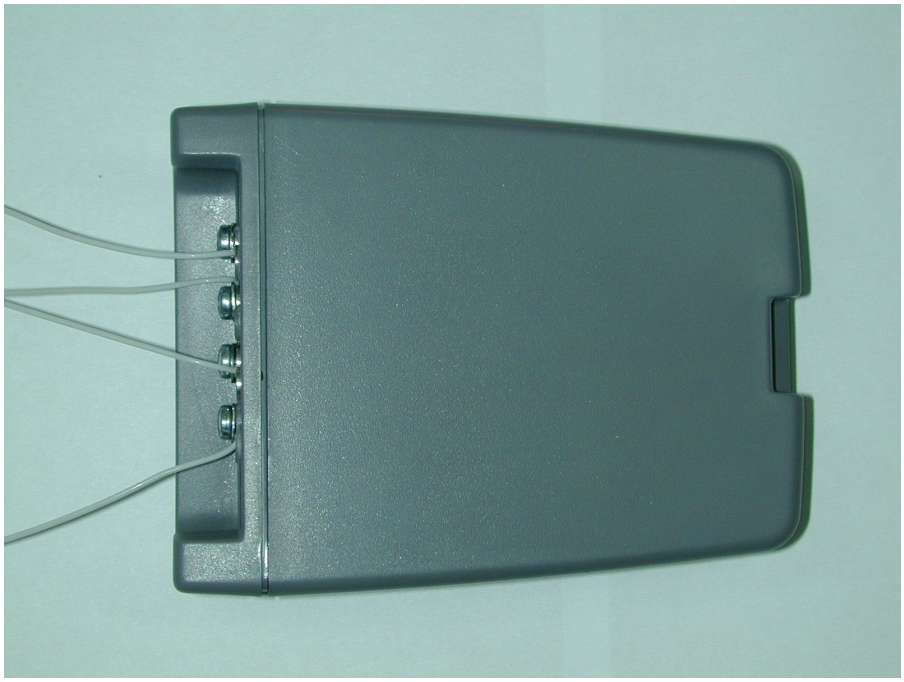
3.2 EUT test configuration

The EUT operating frequencies generated by clocks and oscillators are provided in Table 3.2.1 and test configuration - in Figure 3.2.1.

Table 3.2.1 EUT operating frequencies

Frequency, MHz	Description
53.3 MHz	Local oscillator2
852.33 MHz	Local oscillator1
32.768 kHz	Clock1
26.6353 MHz	Clock2

Figure 3.2.1 EUT test configuration



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3.3 EUT technical characteristics

Type of equipment						
X	Stand-alone (Equipment with or without its own control provisions)					
	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)					
	Plug-in card (Equipment intended for a variety of host systems)					
Operating frequency range	916.3 MHz					
Spread spectrum technique used						
	Frequency hopping (FHSS)					
X	Digitally modulated					
	Combined					
Spread spectrum parameters						
X	chip sequence length (bits)	NA				
	spectrum width (MHz)	0.74 at 6 dB level				
Transmitter aggregate data rate (bits per second)	60 kb					
Normal test signal	FSK					
Maximum rated output power						
At transmitter temporary external 50 Ω RF output connector (dBm)	14					
Is transmitter output power variable?	**X**	No				
		Yes		continuous variable		
				stepped variable		
				stepsize :		
				minimum RF power :		
				maximum RF power :		
Transmitter power source						
X	**Battery**	**Nominal rated voltage (VDC)**	**3.6**			
X	Lithium					
	Other					
	DC	**Nominal rated voltage**				
	AC mains	**Nominal rated voltage (VAC)**				
Is there common power source for transmitter and receiver	**X**	yes		no		

Antenna technical characteristics				
	Type	**Manufacturer**	**Model number**	**Gain, dBi**
Integral with temporary RF connector	PIFA	Telematics	NA	3

External antenna connection - NA		

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4 Test results

4.1 Occupied bandwidth for digitally modulated systems according to § 15.247(a) (2)

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.7
DATE:	April 9, 2003
RELATIVE HUMIDITY:	44 %
AMBIENT TEMPERATURE:	24°C
AIR PRESSURE:	1013 hPa
OPERATING FREQUENCY RANGE:	902-928 MHz
MODULATION TECHNIQUE:	Digitally modulated
BIT RATE:	60 kbps
MEASUREMENT UNCERTAINTY:	+0.36/-0.38 dB

Carrier frequency, MHz	Measured 6 dB bandwidth, kHz	Reference to Plot in Appendix A
916.3	740	A1

LIMIT

Operating frequency range, MHz	Minimum allowed bandwidth
902 – 928	≥ 500 kHz @ 6 dBc

TEST PROCEDURE

The EUT RF output was connected via 20 dB attenuator to the spectrum analyzer, which settings are shown in the plot. The measurements were performed in normal (transmitting) mode of operation.

TEST EQUIPMENT USED:

HL 1430	HL 1650					

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4.2 Maximum peak output power test according to §15.247 (b)(3)

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.4
DATE:	April 9, 2003
RELATIVE HUMIDITY:	44 %
AMBIENT TEMPERATURE:	24°C
AIR PRESSURE:	1013 hPa
OPERATING FREQUENCY RANGE	902-928 MHz
MODULATION TECHNIQUE	Digitally modulated
BIT RATE:	60 kbps
MEASUREMENT UNCERTAINTY:	± 1.7 dB

Carrier frequency, MHz	Peak output power, dBm	Limit, dBm	Margin, dB	Reference to Plots in Appendix A
916.3	13.3	30	16.7	A2

LIMIT

Operating frequency range, MHz	Maximum peak output power, W
902-928	1

TEST PROCEDURE

The EUT RF output was connected via 20 dB attenuator to the spectrum analyzer, which settings are shown in the plot. The measurements were performed in normal (transmitting) mode of operation.

TEST EQUIPMENT USED:

HL 1430	HL 1650					

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

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.5
DATE:	April 9, 2003
RELATIVE HUMIDITY:	44 %
AMBIENT TEMPERATURE:	24°C
AIR PRESSURE:	1013 hPa
OPERATING FREQUENCY RANGE	902 - 928 MHz
MODULATION TECHNIQUE	Digitally modulated
BIT RATE:	60 kbps
FREQUENCY RANGE*	9 kHz – 9.2 GHz
MEASUREMENT UNCERTAINTY:	± 4.3 dB

* The frequency spectrum was investigated from 9 kHz up to the tenth harmonic of the fundamental frequency.
For test results refer to Plots A3 – A18.

Frequency, GHz	Resolution bandwidth, kHz	Spurious emission level, dBm	Calculated limit, dBm	Reference to Plots in Appendix A
0.8898	100	-62.25	-7.4	A9
0.928	100	-64.46	-7.4	A10
1.8325	100	-54.43	-7.4	A11, A12
2.7487	100	-68.06	-7.4	A13, A14

LIMIT

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

TEST PROCEDURE

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

TEST EQUIPMENT USED:

HL 1424	HL 1430	HL 1650			

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4.4 Radiated emissions which fall in restricted bands test according to §15.247(c) and § 15.205, §15.209(a)

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.4
DATE:	April 9, 16, 2003
RELATIVE HUMIDITY:	44 %
AMBIENT TEMPERATURE:	24°C
AIR PRESSURE:	1013 hPa
OPERATING FREQUENCY RANGE	902-928 MHz
MODULATION TECHNIQUE	Digitally modulated
Measurement uncertainty:	± 4.5 dB

The frequency spectrum was investigated from 9 kHz up to the tenth harmonic of the fundamental frequency. All emissions were found below the specified limit. For test results refer to Plots A20 – A30.

Peak detector

Frequency, MHz	Radiated emissions, dB(μV/m)	Limit, dB (μV/m)	Margin, dB	Reference to Plots in Appendix A
266.37	29.53	46*	16.47	A21
273.03	27.24	46*	18.76	A21
279.69	30.76	46*	15.24	A21
332.94	27.09	46*	19.91	A21
2748.4	60.3	74	13.7	A26
3666.0	51.5	74	22.5	A27
4580.6	56.1	74	17.9	A28
7330.5	56.5	74	17.5	A29

***** quasi-peak limit

Average value = Peak value + Average factor

Frequency, MHz	Radiated emissions, dB(μV/m)	Limit, dB (μV/m)	Margin, dB	Reference to Plots in Appendix A
2748.4	35.1	54	18.9	A26
3666.0	26.3	54	27.7	A27
4580.6	30.9	54	23.1	A28
7330.5	31.3	54	22.7	A29

Table abbreviations:
Margin = dB below (negative if above) specification limit.

4.4.1 Average factor calculation, §15.35

Tx ON, ms	Duty cycle	Average factor, dB	Reference to Plots in Appendix A
5.5 *	0.055	-25.2	A31 – A33
Measurement uncertainty (1% of sweep time)		**0.2 ms**	

* The extended data transmission duration (declared by customer) was used for calculating the average factor, whereas the "regular" data transmission duration was 3.8 ms as shown in Plot A32.

LIMIT

Radiated emissions, which fall in the restricted bands, must comply with §15.209(a) limits.

TEST PROCEDURE

9 kHz – 30 MHz frequency range. The loop antenna was positioned with its plane vertical. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated about its vertical axis.

30 MHz – 9.2 GHz frequency range. The EUT was placed on a wooden 80 cm height turntable. To find maximum radiation the turntable was rotated 360°, measuring antenna height was changed from 1 to 4 m, and the antennas polarization was changed from vertical to horizontal.

TEST EQUIPMENT USED:

HL 0038	HL 0091	HL 0287	HL 0410	HL 0446	HL 0465	HL 0521	HL 0589
HL 0604	HL 1003	HL 1004	HL 1200	HL 1424	HL 1567	HL 1826	HL 1849
HL 1850	HL 1942	HL 1984	HL 2009	HL 2109	HL 2259		

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4.5 Peak power spectral density of digitally modulated systems according to § 15.247(d)

DATE:	June 19, 2003
RELATIVE HUMIDITY:	44 %
AMBIENT TEMPERATURE:	24°C
AIR PRESSURE:	1013 hPa
OPERATING FREQUENCY RANGE	902 - 928 MHz
MODULATION TECHNIQUE	Digitally modulated
LIMIT FOR PEAK POWER SPECTRAL DENSITY	8 dBm
MEASUREMENT UNCERTAINTY:	± 4.5 dB

Carrier frequency, MHz	Measured peak power spectral density, dBm/3 kHz	Reference to Plots in Appendix A
916.3	6.79	A34, A35

LIMIT

The peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

TEST PROCEDURE

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

TEST EQUIPMENT USED:

HL 1430	HL 1650					

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4.6 Unintentional radiated emissions test according to §15.109

METHOD OF MEASUREMENT:	ANSI 63.4 §11.6 / ANSI 63.4 §12.1.4
DATE	April 9, 2003
TEST PERFROMED AT:	Anechoic chamber
AMBIENT TEMPERATURE:	24°C
RELATIVE HUMIDITY	44%
DISTANCE BETWEEN ANTENNA AND EUT:	3 m
THE EUT WAS TESTED AS:	Table-top
FREQUECNY RANGE:	30 MHz – 5 GHz
DETECTOR TYPE:	Peak
MODE OF OPERATION	Rx
MEASUREMENT UNCERTAINTY:	± 4.5 dB

No emissions were found in Rx mode. The test results are demonstrated in Plots A36 – A39.

LIMIT (§ 15.109)

Frequency, MHz	Class B equipment @ 3 m dB(μV/m)
30 - 88	40
88 - 216	43.5
216 - 960	46
960 - 5000	54

TEST PROCEDURE

30 MHz – 5 GHz frequency range. The EUT was placed on a wooden 80 cm height turntable. To find maximum radiation the turntable was rotated 360^{o}, measuring antenna height was changed from 1 to 4 m, and the antennas polarization was changed from vertical to horizontal.

TEST EQUIPMENT USED:

HL 0465	HL 0566	HL 0569	HL 1425	HL 1553	HL 1566	HL 1826
HL 1849	HL 1850	HL 2109				

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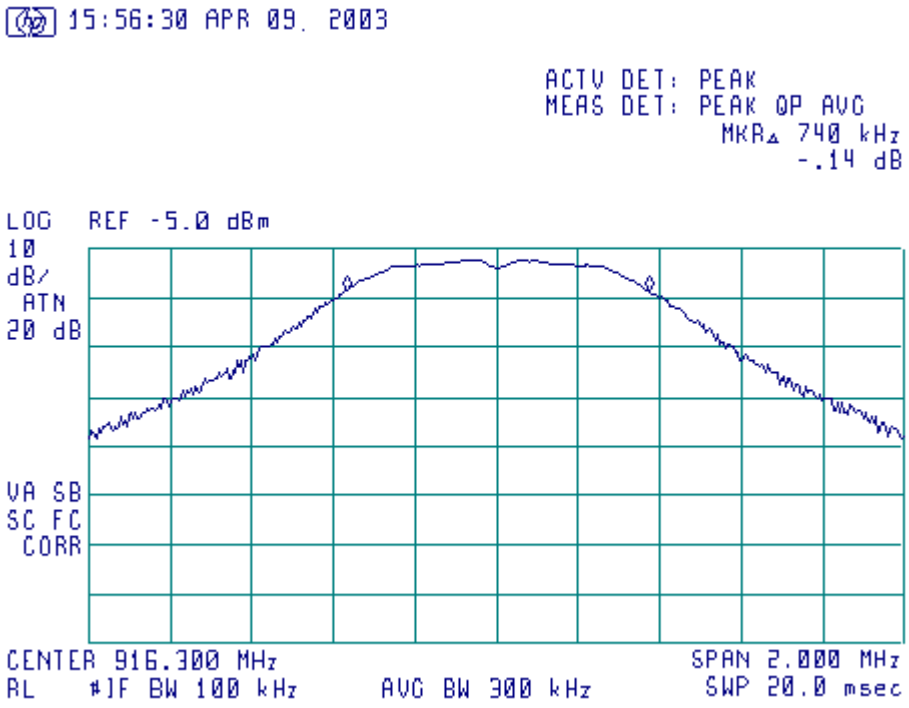
Appendix A Plots

Plot A 1

6 dB bandwidth @ 916.3 MHz



External attenuator 20 dB

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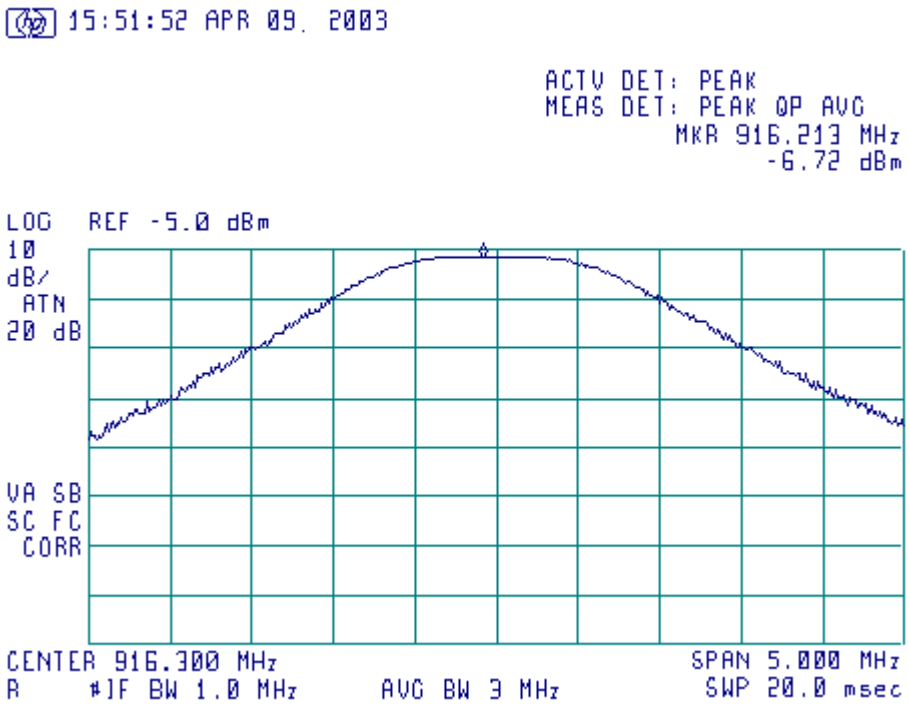
Plot A 2

Peak output power measurements@ 916.3 MHz



External attenuator 20 dB

P_{out} = -6.7 dBm (measured) + 20 dB (ext.att.) = 13.3 dBm

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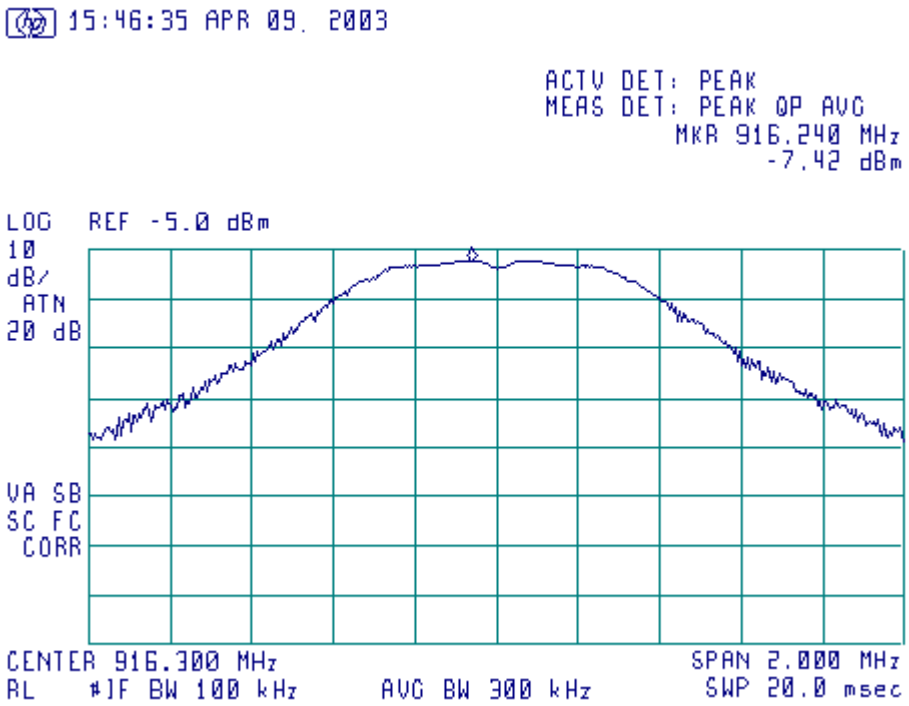
Plot A 3

In-band emission measurements @ 916.3 MHz carrier



External attenuation 20 dB

The highest in-band emission level in 100 kHz bandwidth = -7.4 dBm (measured) + 20 dB (ext. att.) = 12.8 dBm.

Conducted spurious emissions limit = 12.8 dBm – 20 dB (§15.247 (5) (c) requirement) = -7.4 dBm

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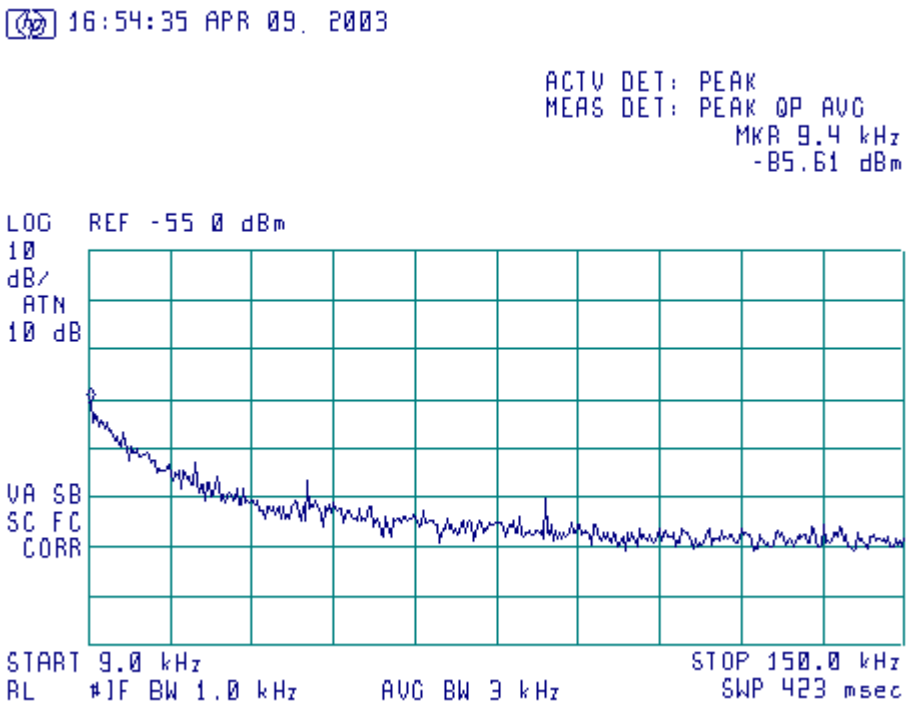
Plot A 4

Conducted spurious emission measurements in 9 kHz – 150 kHz



External attenuation 20 dB.

No spurious emissions were found.

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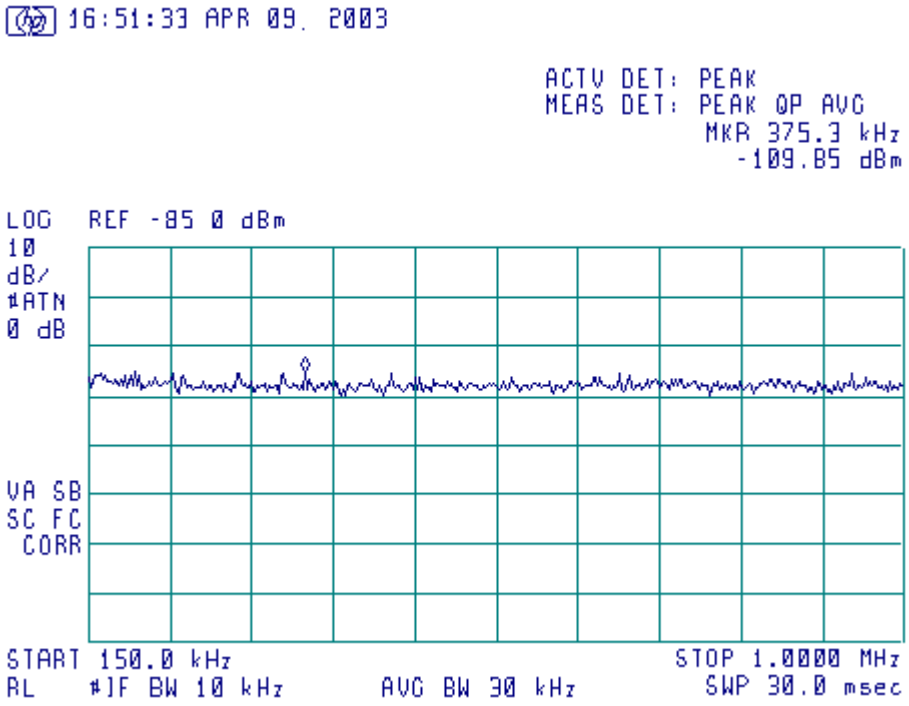
Plot A 5

Conducted spurious emission measurements in 150 kHz – 1 MHz



External attenuation 20 dB.

No spurious emissions were found.

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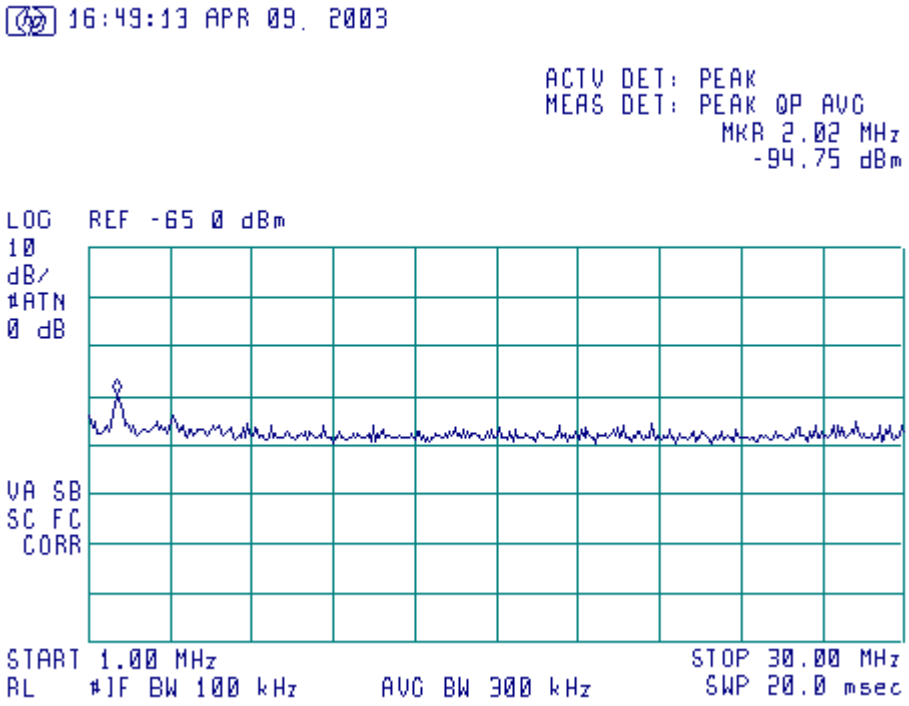
Plot A 6

Conducted spurious emission measurements in 1 MHz – 30 MHz



External attenuation 20 dB.

No spurious emissions were found.

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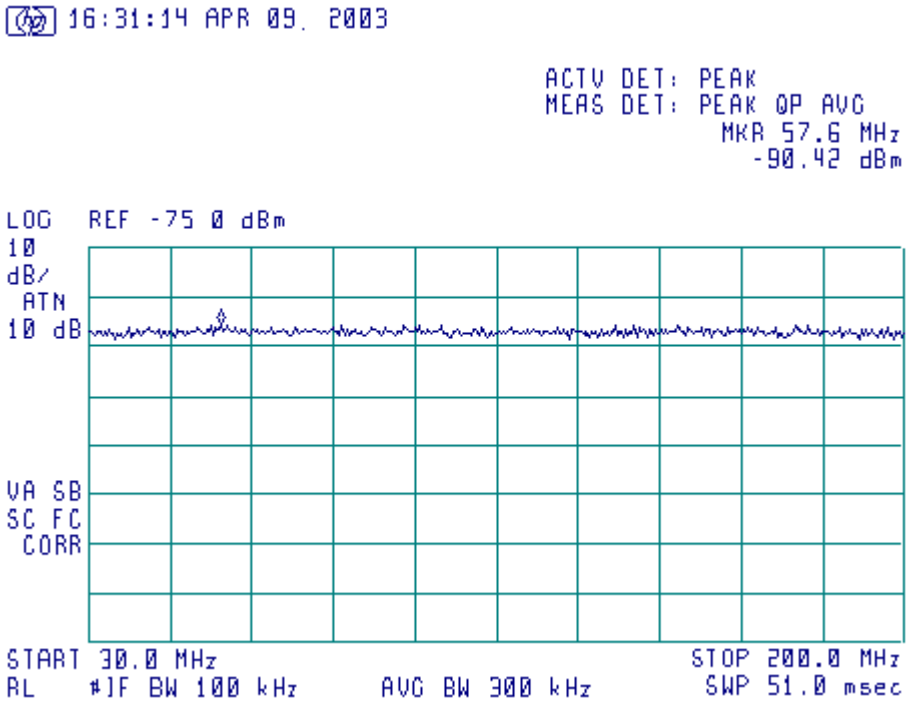
Plot A 7

Conducted spurious emission measurements in 30 MHz – 200 MHz



External attenuation 20 dB.

No spurious emissions were found.

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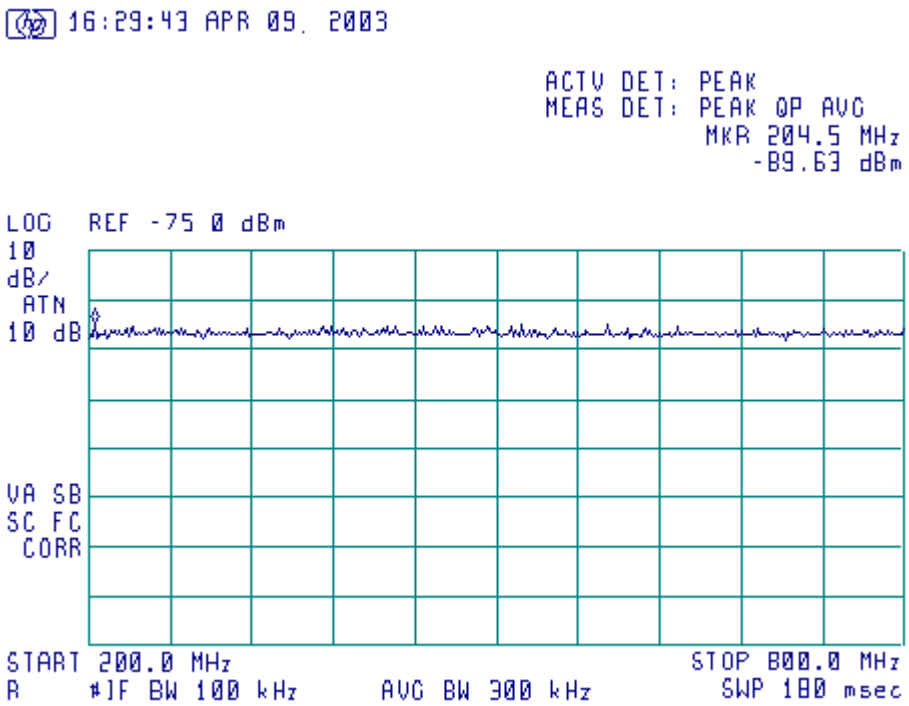
Plot A 8

Conducted spurious emission measurements in 200 MHz – 800 MHz



External attenuation 20 dB.

No spurious emissions were found.

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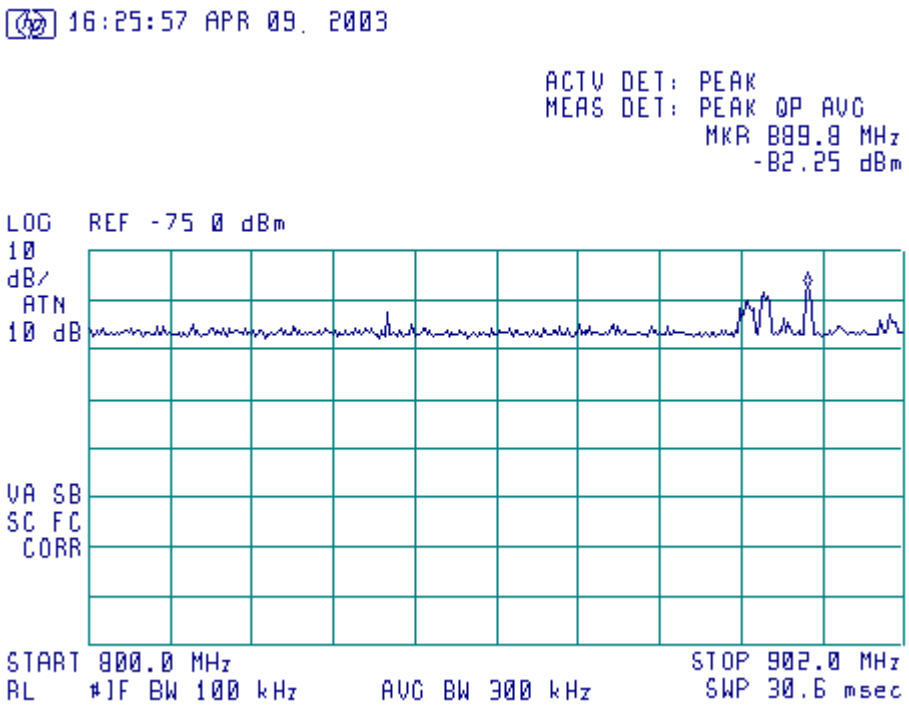
Plot A 9

Conducted spurious emission measurements in 800 MHz – 902 MHz



External attenuation 20 dB.

-82.25 dBm (measured) + 20 dB (ext. att.) = -62.25 dBm

Conducted spurious emissions limit = -7.4 dBm

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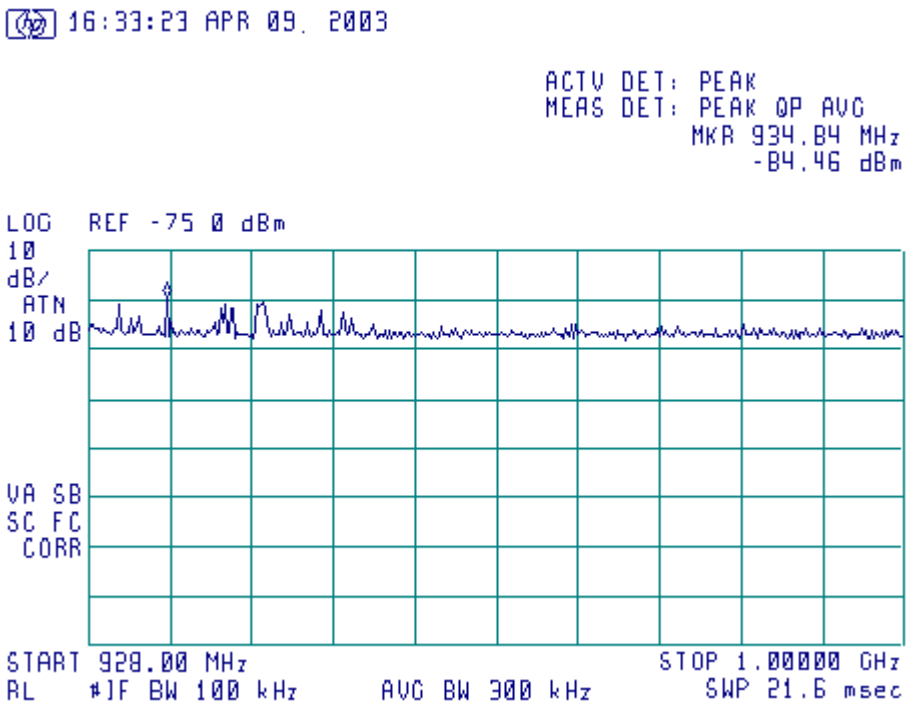
Plot A 10

Conducted spurious emission measurements in 928 MHz – 1000 MHz



External attenuation 20 dB.

-84.46 dBm + 20 dB (ext. att.) = -64.46 dBm

Conducted spurious emissions limit = -7.4 dBm

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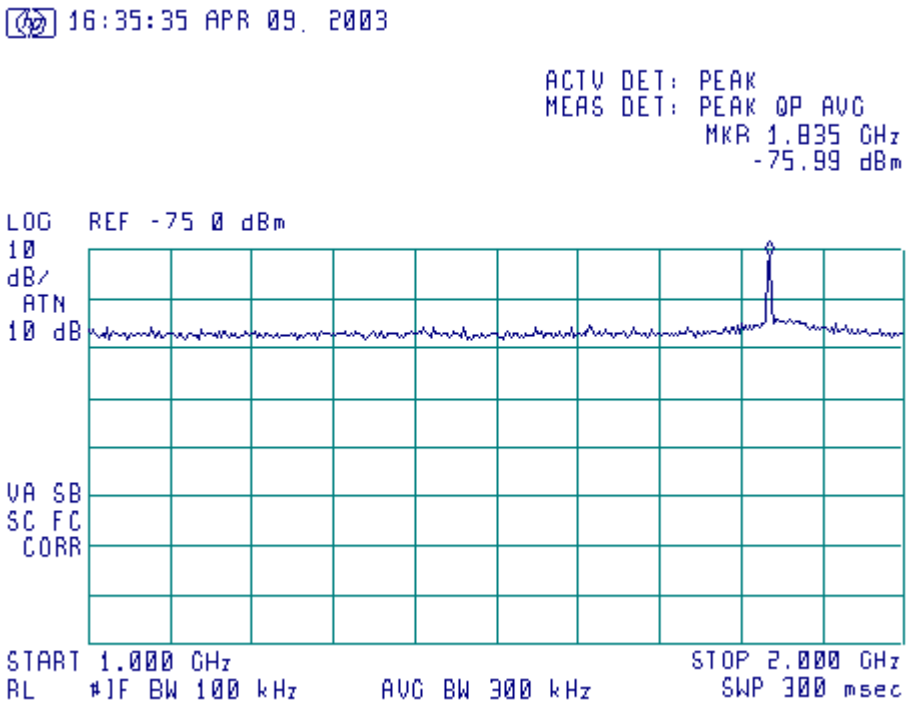
Plot A 11

Conducted spurious emission measurements in 1000 MHz – 2000 MHz



External attenuation 20 dB.

No spurious emissions except the 2nd harmonic of fundamental were found.

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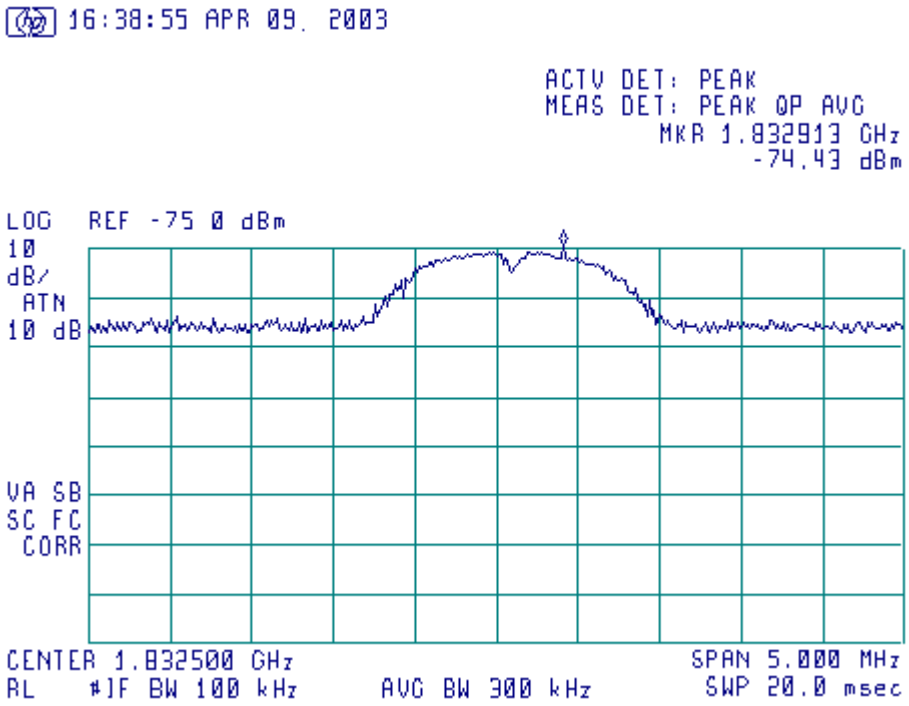
Plot A 12

**Conducted spurious emission measurements,
center 1832.5 MHz**



The 2nd harmonic of the fundamental : -74.43 dBm (measured) + 20 dB (ext. att.) = -54.43 dBm.

Conducted spurious emissions limit = -7.4 dBm

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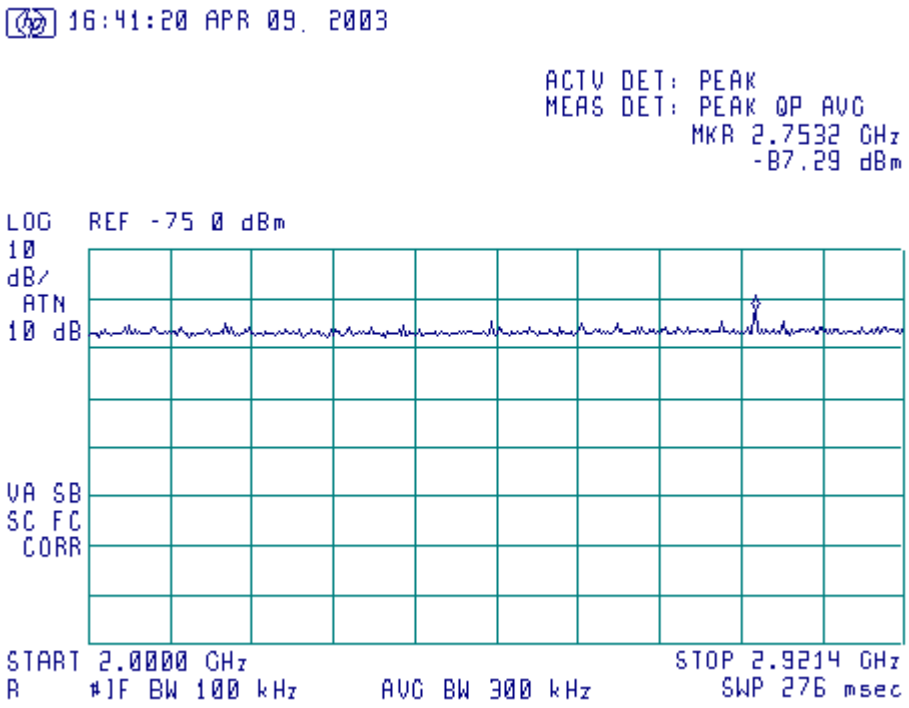
Plot A 13

Conducted spurious emission measurements in 2000 MHz – 2921.4 MHz



External attenuation 20 dB.

No spurious emissions except the 3rd harmonic of fundamental were found.

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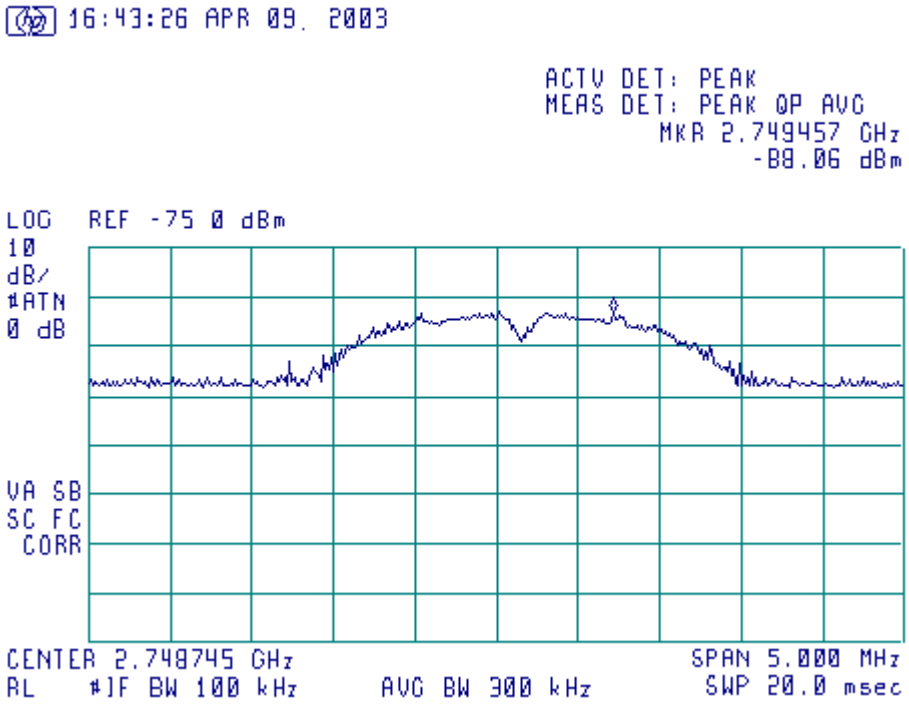
Plot A 14

**Conducted spurious emission measurements,
center 2748.74 MHz**



The 3rd harmonic of the fundamental : -88.06 dBm (measured) + 20 dB (ext. att.) = -68.06 dBm.

Conducted spurious emissions limit = -7.4 dBm

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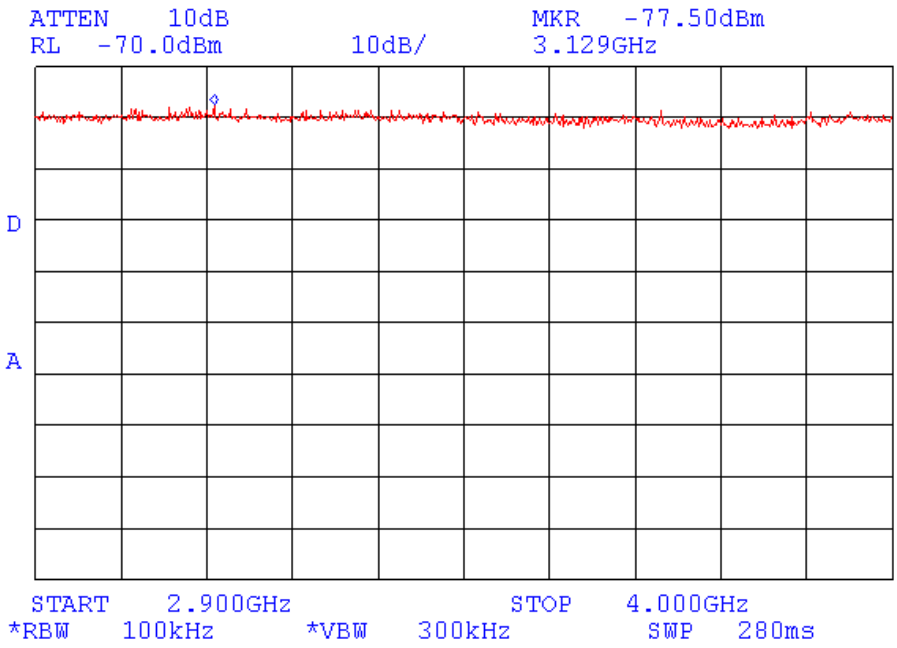
Plot A 15

Conducted spurious emission measurements in 2900 MHz – 4000 MHz



External attenuation 20 dB.

No spurious emissions were found.

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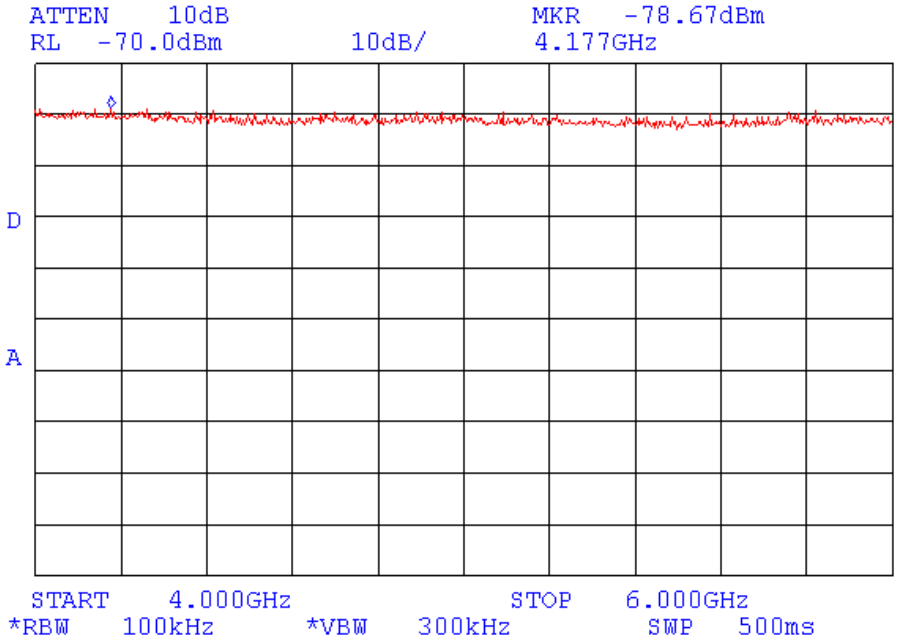
Plot A 16

Conducted spurious emission measurements in 4000 MHz – 6000 MHz



External attenuation 20 dB.

No spurious emissions were found.

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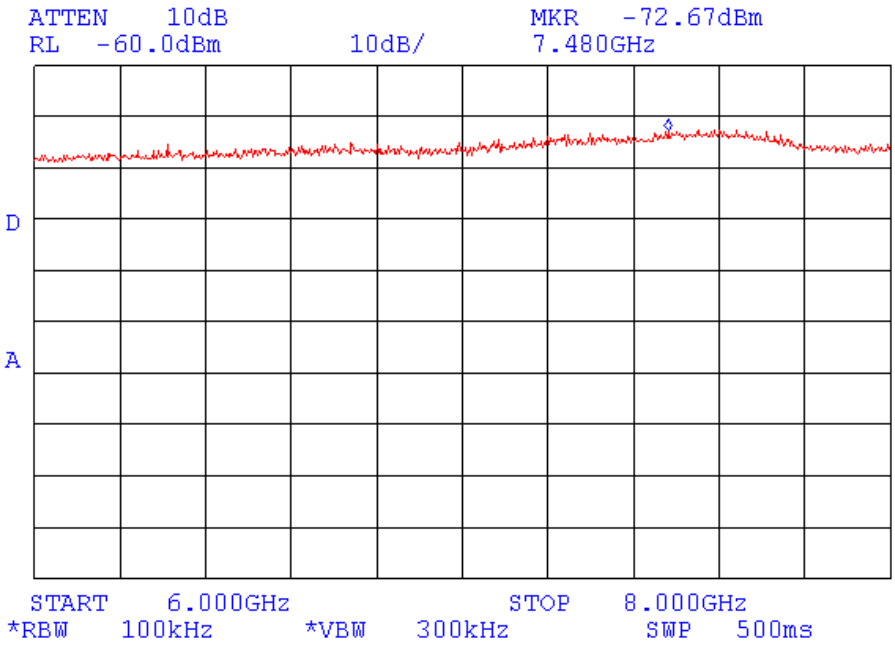
Plot A 17

Conducted spurious emission measurements in 6090 MHz – 8000 MHz



External attenuation 20 dB.

No spurious emissions were found.

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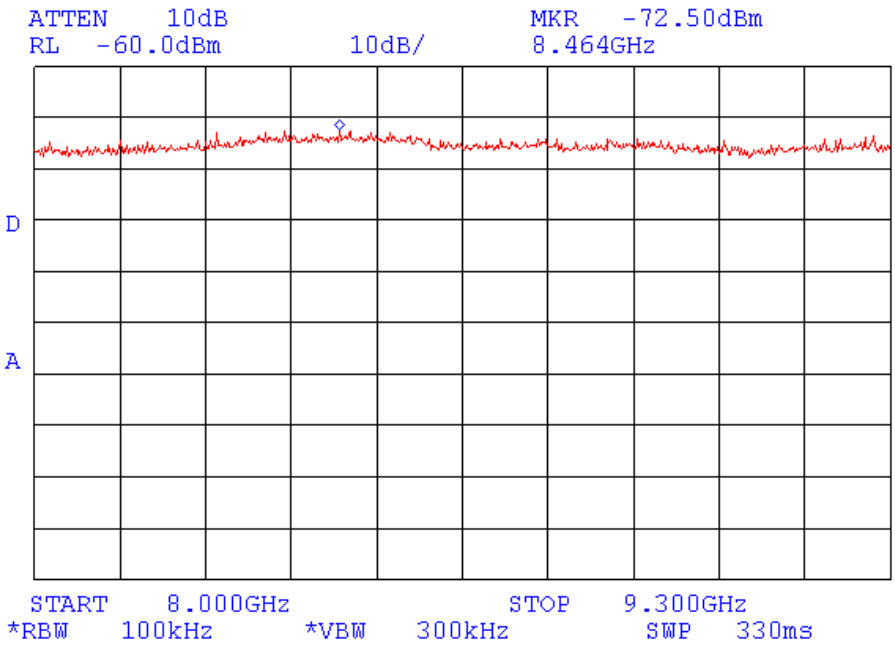
Plot A 18

Conducted spurious emission measurements in 8090 MHz – 9300 MHz



External attenuation 20 dB.

No spurious emissions were found.

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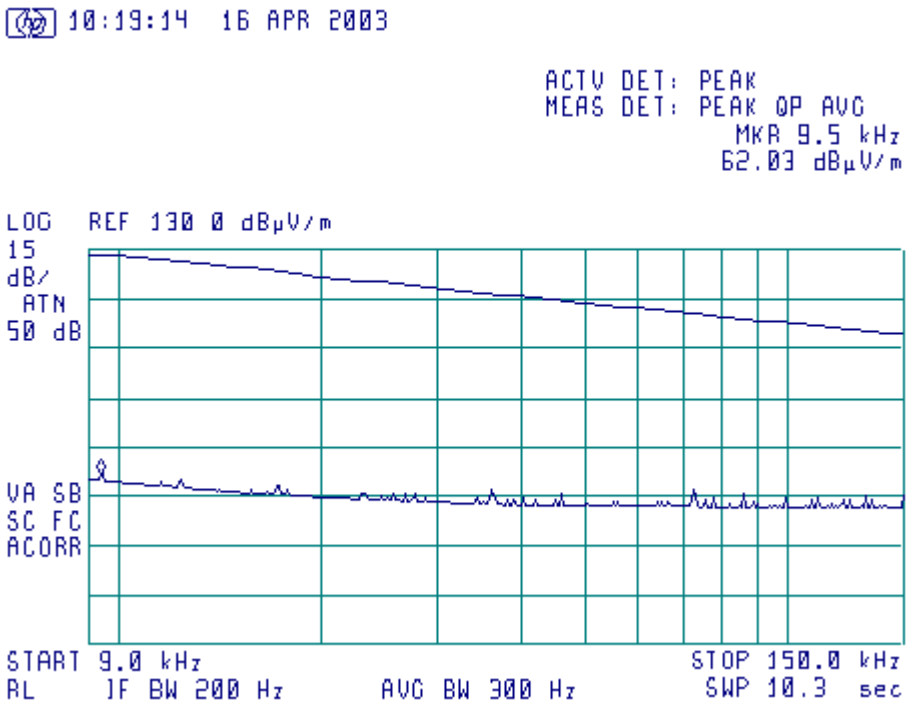
Plot A 19

Radiated spurious emission measurements in 9 kHz – 150 kHz



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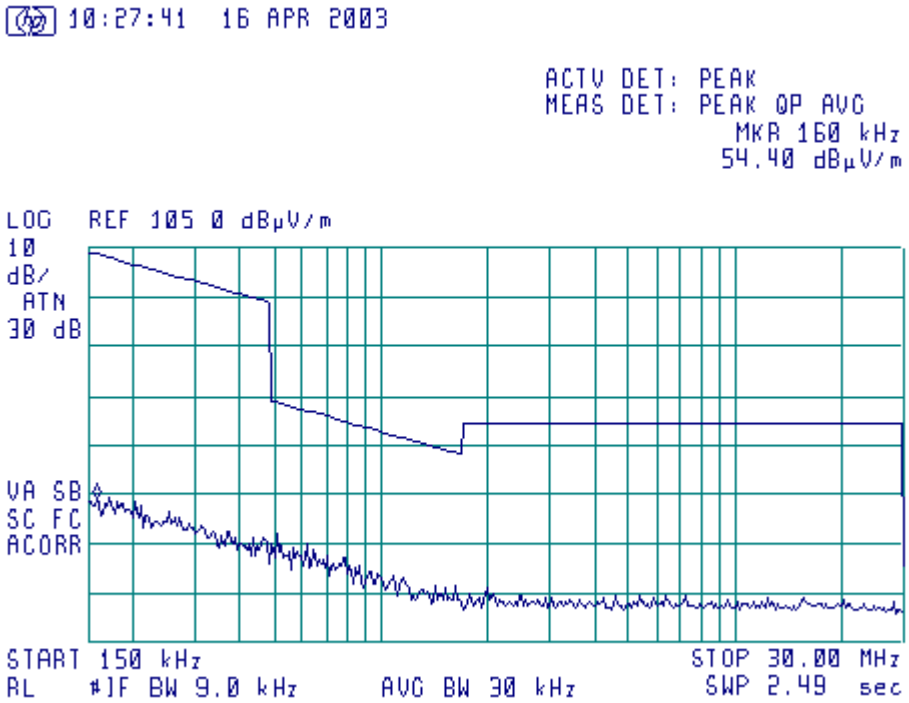
Plot A 20

Radiated spurious emission measurements in 150 kHz – 30 MHz



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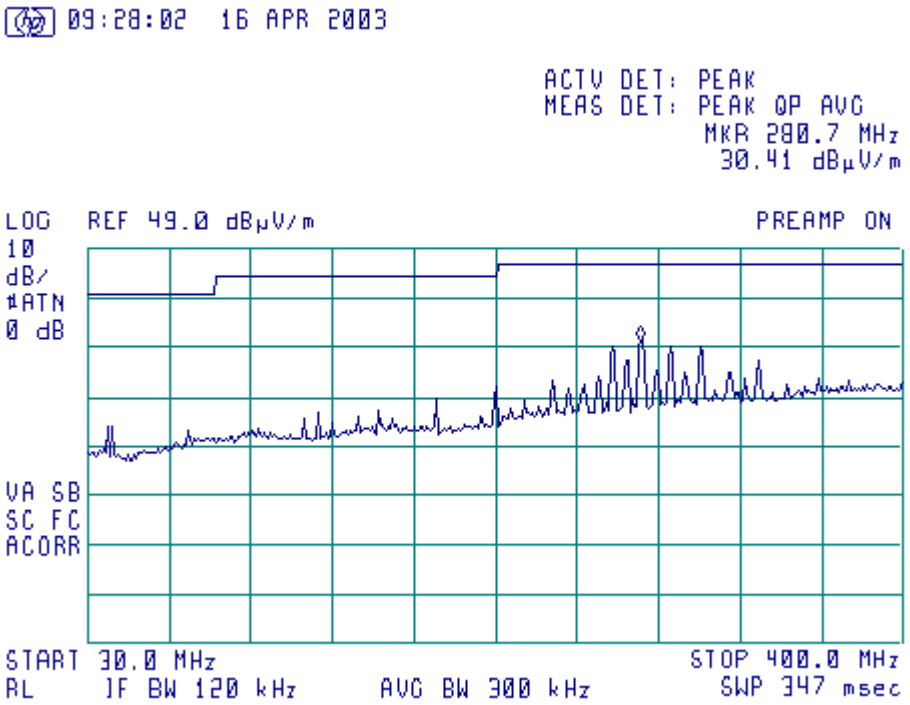
Plot A 21

Radiated spurious emission measurements in 30 MHz – 400 MHz



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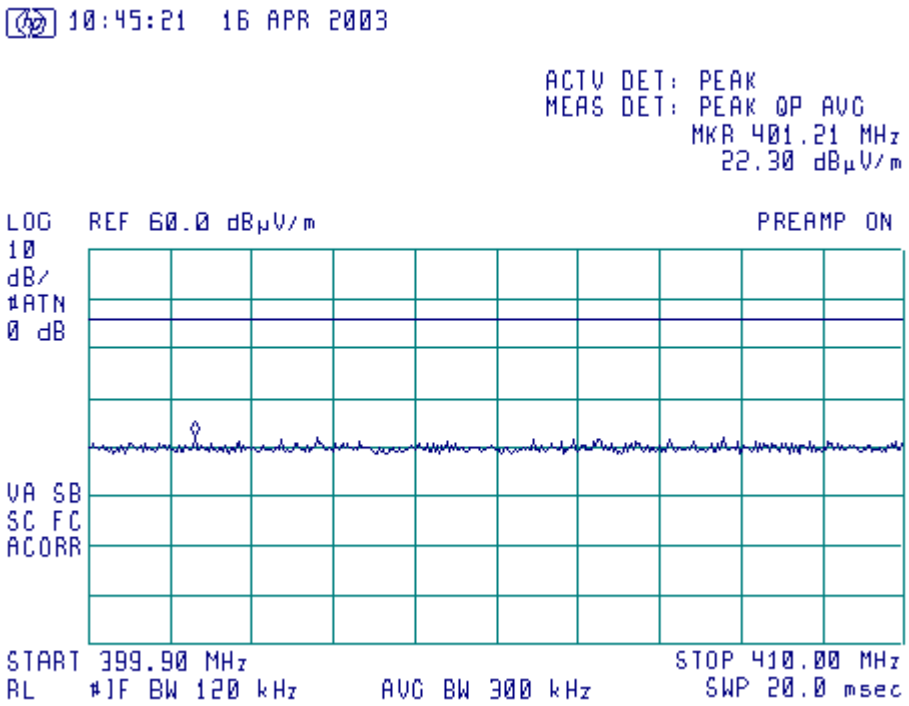
Plot A 22

Radiated spurious emission measurements in 399.9 MHz – 410 MHz



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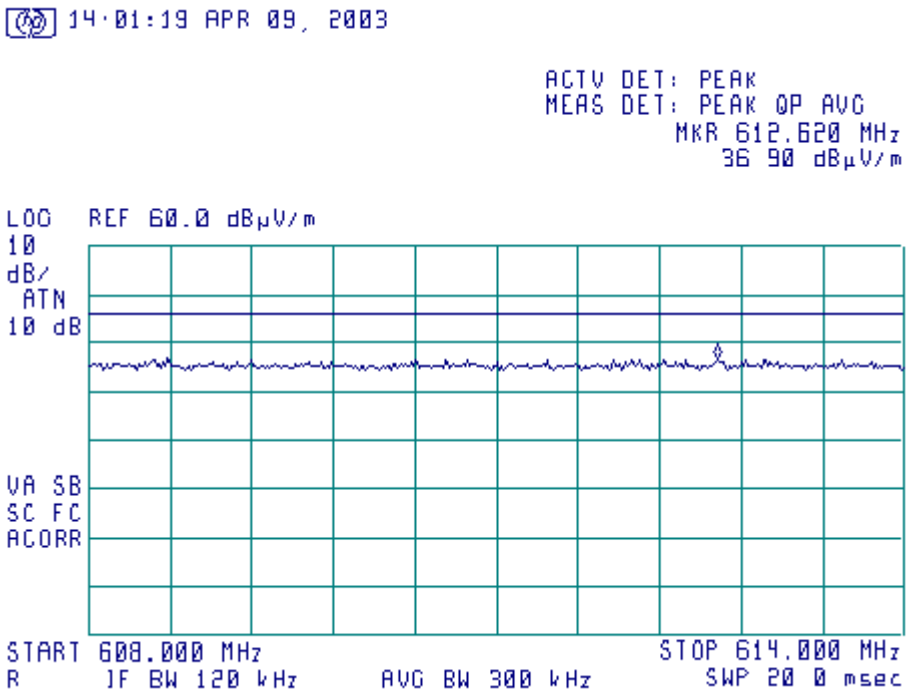
Plot A 23

Radiated spurious emission measurements in 608 MHz – 614 MHz



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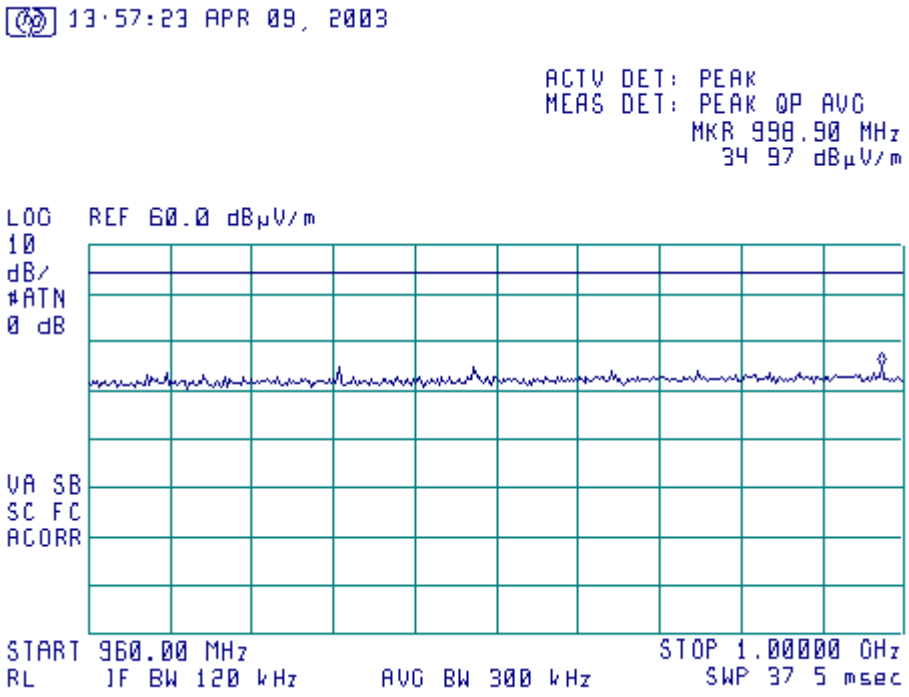
Plot A 24

Radiated spurious emission measurements in 960 MHz - 1000 MHz



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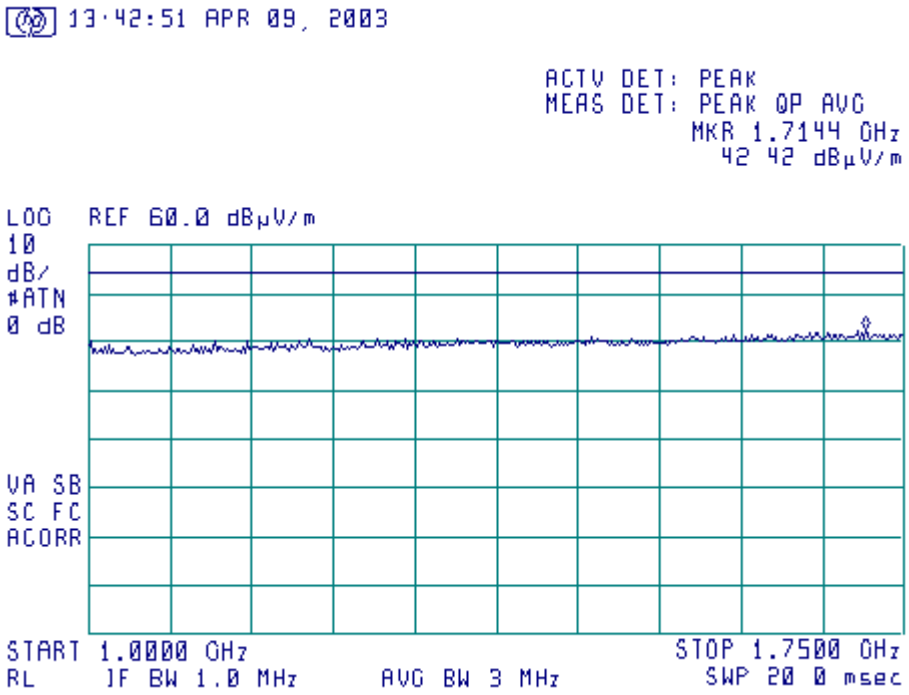
Plot A 25

Radiated spurious emission measurements in 1000 MHz – 1750 MHz



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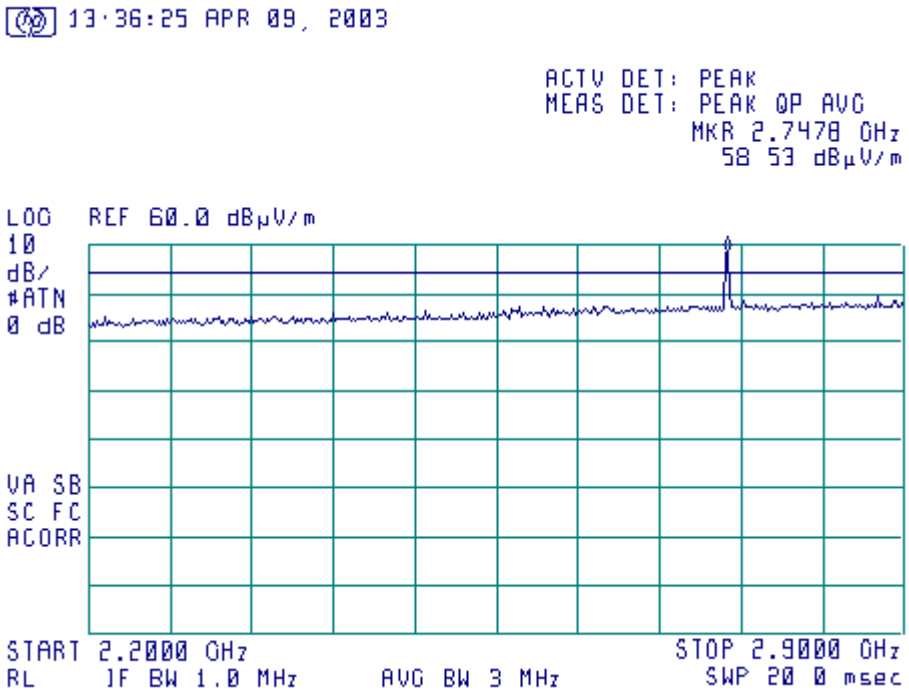
Plot A 26

Radiated spurious emission measurements in 2200 MHz – 2900 MHz



The 3rd harmonic of fundamental: 2.7484 GHz, OATS measurements @ 3 m.

Peak value=60.3 dB(µV/m)

Limit for peak measurement =74 dB(µV/m)

Average factor = 20xlog(5.5msec/100msec)=-25.2 dB

Average value = 60.3 dB(µV/m) – 25.2 dB = 35.1 dB(µV/m)

Limit for average measurement =54 dB(µV/m)

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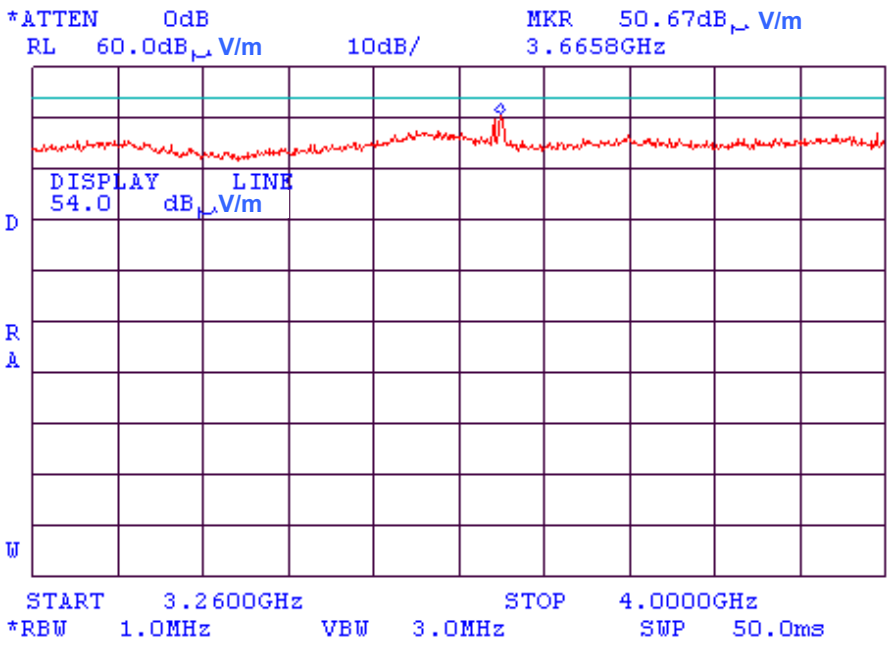
Plot A 27

Radiated spurious emission measurements in 3260 MHz – 4000 MHz



The 4th harmonic of fundamental: 3.666 GHz, OATS measurements @ 3 m.

Peak value = 51.5 dB(µV/m) Limit for peak measurement =74 dB(µV/m)

Average factor = 20xlog(5.5msec/100msec)=-25.2 dB

Average value = 51.5 dB(µV/m) – 25.2 dB=26.3 dB(µV/m) Limit for average measurement =54 dB(µV/m)

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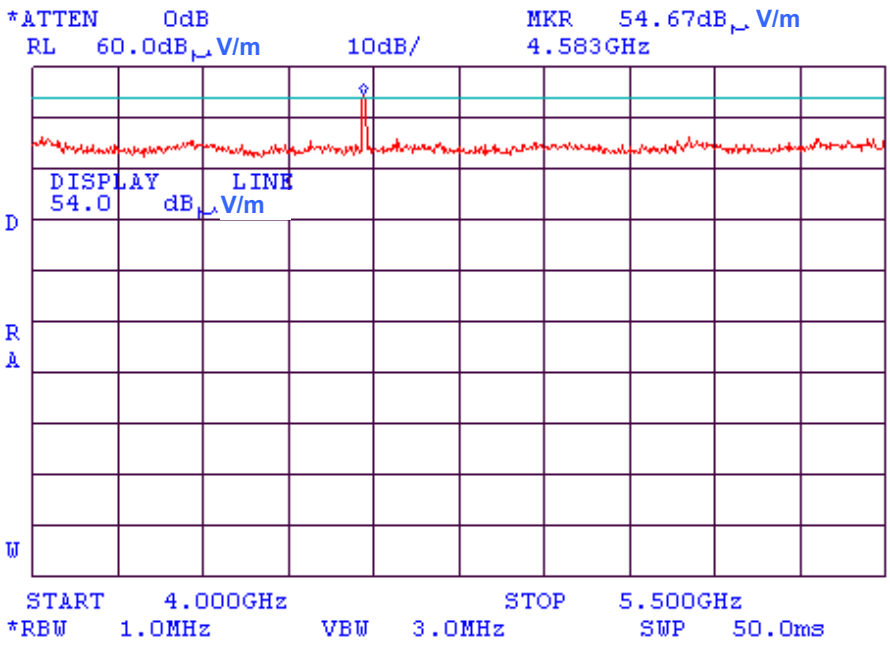
Plot A 28

Radiated spurious emission measurements in 4000 MHz – 5500 MHz



The 5th harmonic of fundamental: 4.5806 GHz, OATS measurements @ 3 m.

Peak value = 56.1 dB(µV/m) Limit for peak measurement =74 dB(µV/m)

Average factor = 20xlog(5.5msec/100msec)=-25.2 dB

Average value = 56.1 dB(µV/m) – 25.2 dB=30.9 dB(µV/m) Limit for average measurement =54 dB(µV/m)

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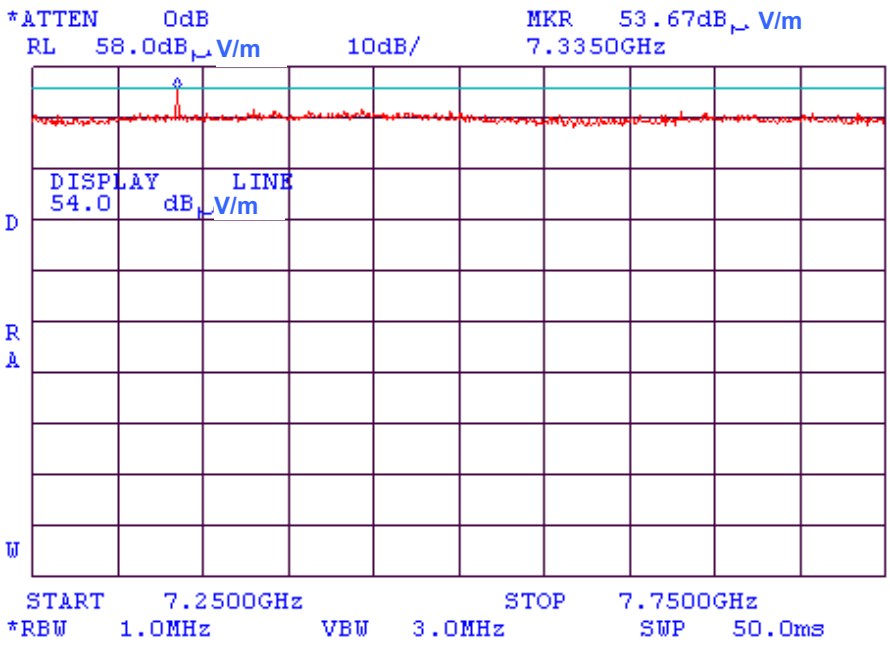
Plot A 29

Radiated spurious emission measurements in 7250 MHz – 7750 MHz



The 8th harmonic of fundamental: 7.3305 GHz, OATS measurements @ 3 m.

Peak value = 56.5 dB(µV/m) Limit for peak measurement =74 dB(µV/m)

Average factor = 20xlog(5.5msec/100msec)=-25.2 dB

Average value = 56.5 dB(µV/m) – 25.2 dB=31.3 dB(µV/m) Limit for average measurement =54 dB(µV/m)

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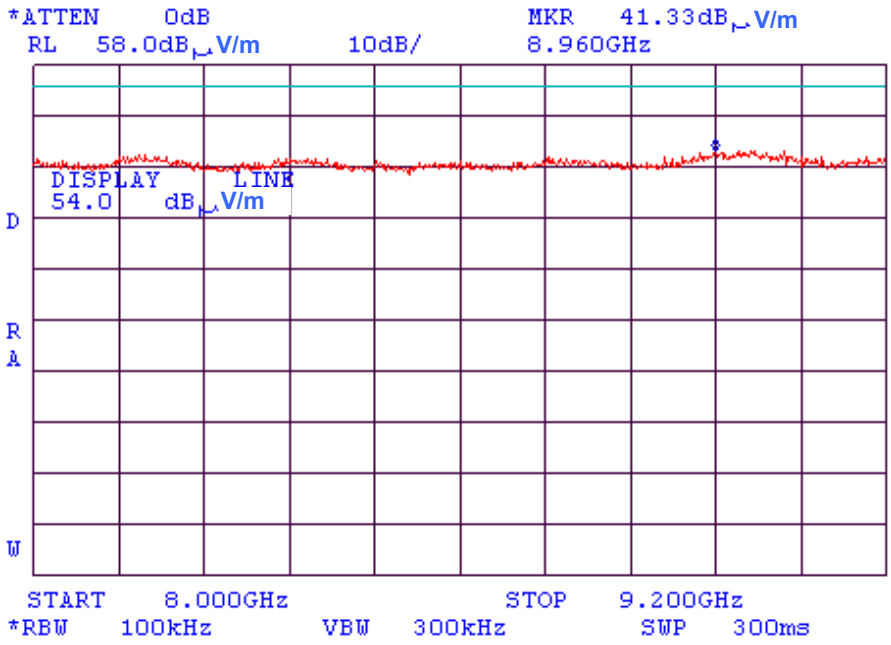
Plot A 30

Radiated spurious emission measurements in 8000 MHz – 9200 MHz



No spurious emissions were found.

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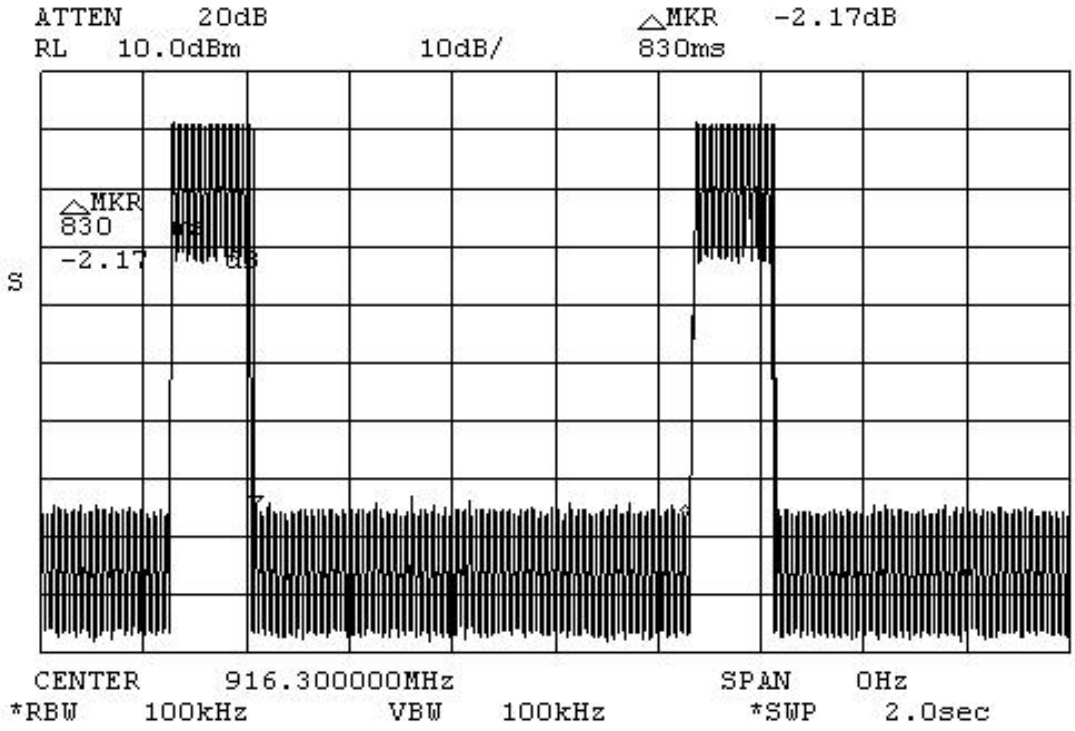
Plot A 31

Interval between two successive bursts during the testing



The interval between two successive bursts is 830 ms

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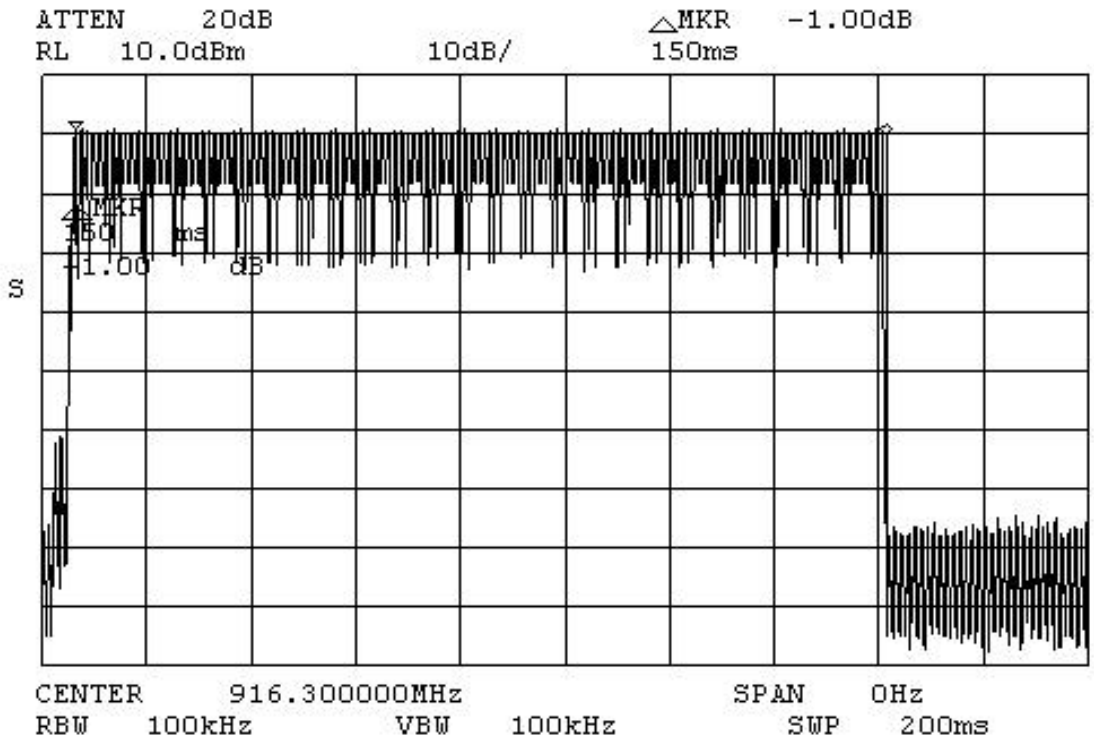
Plot A 32

One burst (26 transmissions) duration during the testing



One burst duration is 150 ms

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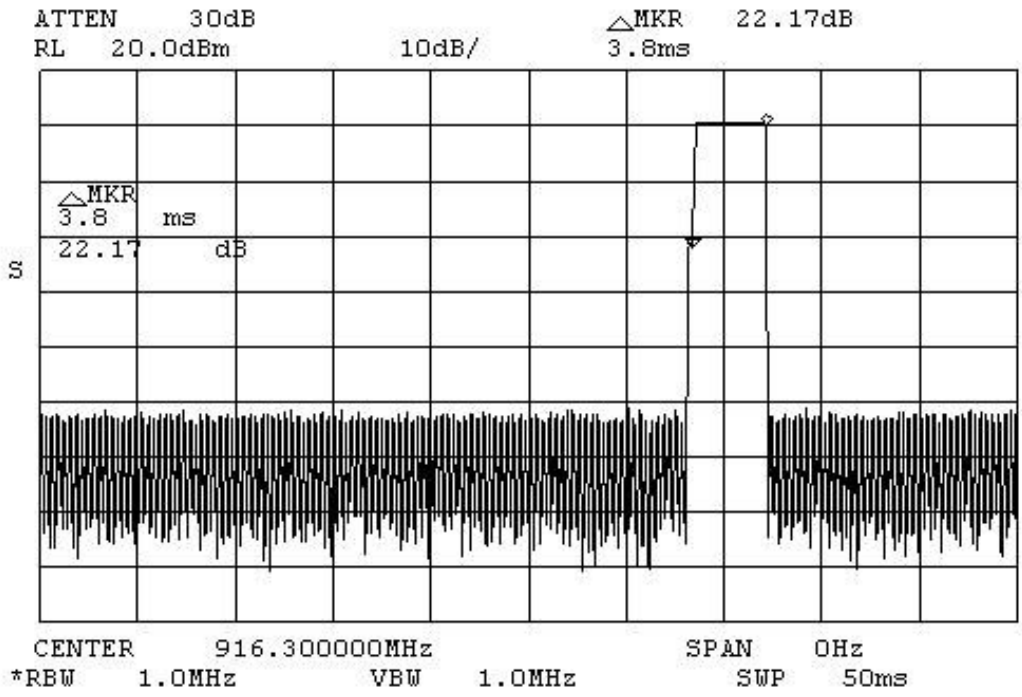
Plot A 33

Single transmission duration



Single transmission duration is 3.8 ms

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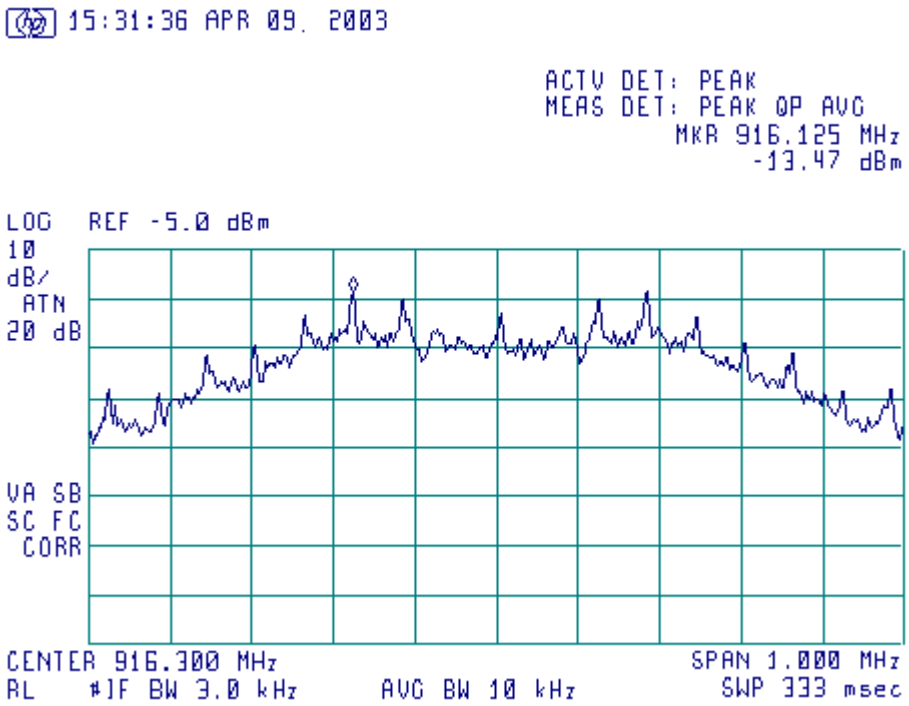
Plot A 34

Peak power spectral density measurements



External attenuator 20 dB

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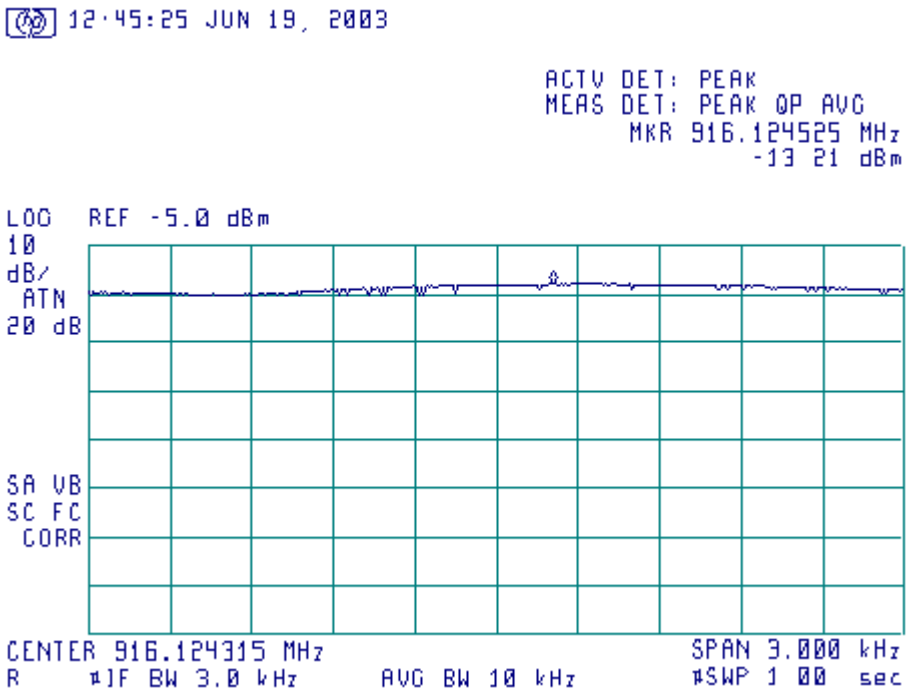
Plot A 35

Peak power spectral density measurements



External attenuator 20 dB

Power density = -13.21 dBm (measured) + 20 dB (ext.att.) = 6.79 dBm
The specified limit = 8 dBm

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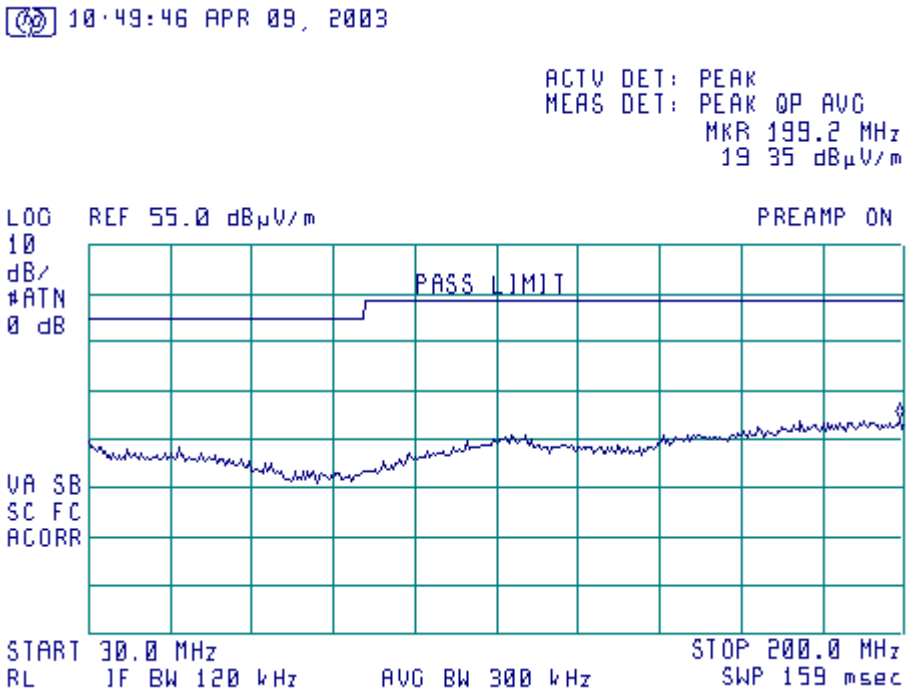
Plot A 36

Unintentional radiated emission measurements in 30 MHz – 200 MHz



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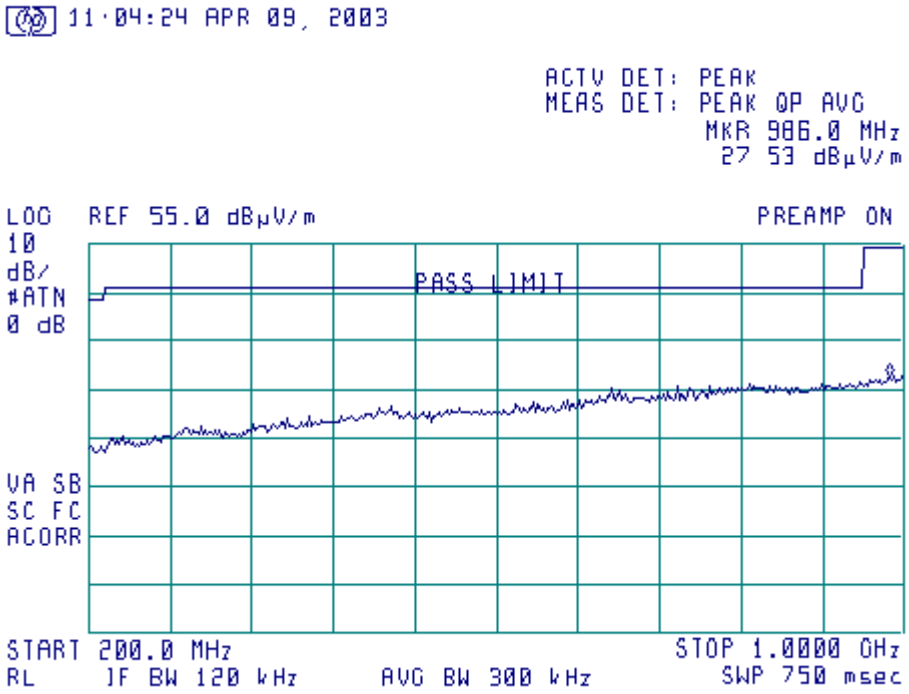
Plot A 37

Unintentional radiated emission measurements in 200 MHz – 1000 MHz



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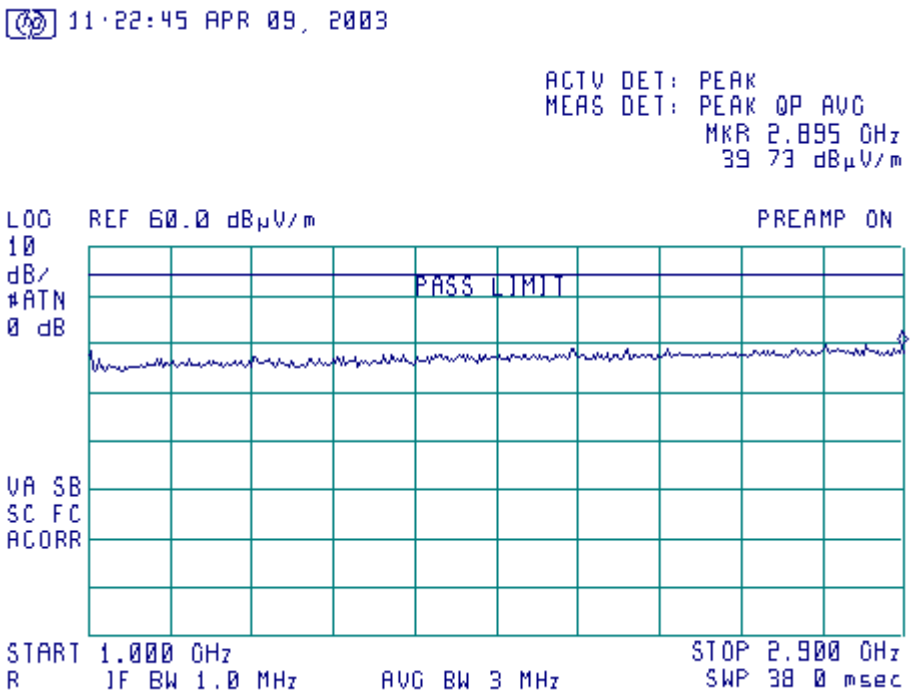
Plot A 38

Unintentional radiated emission measurements in 1000 MHz – 2900 MHz



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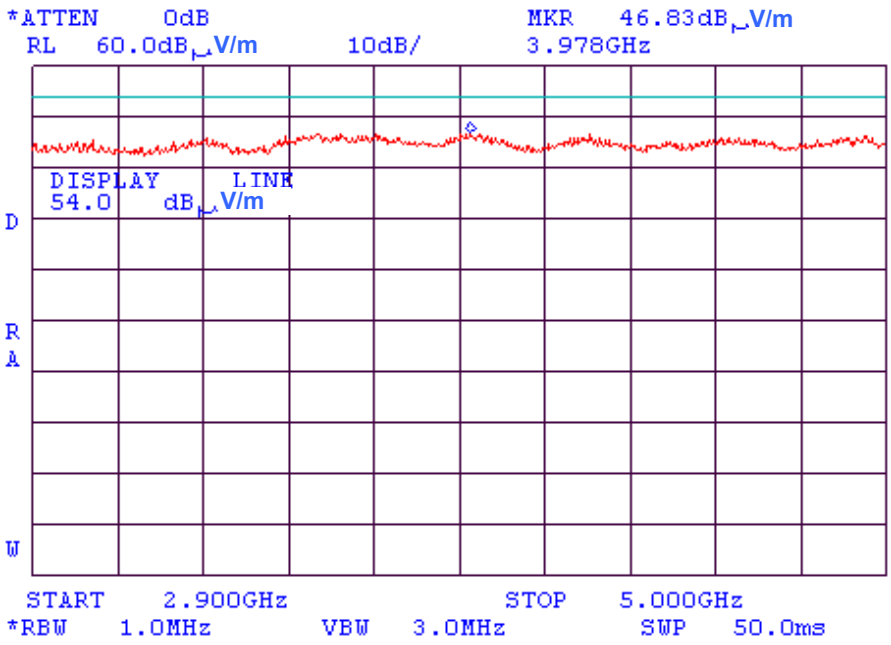
Plot A 39

Unintentional radiated emission measurements in 2900 MHz – 5000 MHz



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Appendix B Antenna factors and cable loss

Antenna Factor
Active Loop Antenna
Model 6502
S/N 2857 (HL 0446)

Frequency, MHz	Magnetic antenna factor, dB	Electric antenna factor, dB
0.009	-32.8	18.7
0.010	-33.8	17.7
0.020	-38.3	13.2
0.050	-41.1	10.4
0.075	-41.3	10.2
0.100	-41.6	9.9
0.150	-41.7	9.8
0.250	-41.6	9.9
0.500	-41.8	9.8
0.750	-41.9	9.7
1.000	-41.4	10.1
2.000	-41.5	10.0
3.000	-41.4	10.2
4.000	-41.4	10.1
5.000	-41.5	10.1
10.000	-41.9	9.6
15.000	-41.9	9.6
20.000	-42.2	9.3
25.000	-42.8	8.7
30.000	-44.0	7.5

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

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Antenna factor, 3 m test distance
Biconical antenna
Electro-Metrics, model BIA-25/30
Ser.No.3566 (HL 0566)

Frequency MHz	Antenna Factor dB(1/m)	Frequency MHz	Antenna Factor dB(1/m)
30	14.7	120	16.8
35	12.9	125	15.5
40	12.6	130	15.5
45	12.8	135	15.1
50	12.6	140	14.8
55	11.8	145	15.1
60	11.7	150	16.9
65	10.4	155	17.2
70	9.2	160	17.3
75	9.1	165	17.8
80	9.1	170	18.3
85	9.5	175	19.0
90	11.2	180	19.5
95	12.6	185	20.0
100	13.7	190	20.4
105	14.2	195	20.5
110	15.3	200	20.6
115	17.1		

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

Antenna factor, 3 m test distance
Log periodic antenna
Electro-Metrics, model LPA-25/30
Ser.No.1953 (HL 0569)

Frequency MHz	Antenna Factor dB(1/m)	Frequency MHz	Antenna Factor dB(1/m)
200	15.2	625	25.2
225	15.1	650	25.8
250	16.3	675	27.2
275	17.2	700	27.6
300	19.6	725	27.6
325	18.4	750	27.6
350	19.0	775	28.0
375	20.0	800	28.2
400	20.9	825	29.4
425	21.3	850	29.9
450	22.1	875	30.0
475	22.7	900	30.4
500	23.2	925	30.6
525	23.9	950	30.8
550	24.2	975	31.6
575	24.6	1000	32.1
600	24.7		

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
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 it to field intensity in dB(μV/m).

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Antenna factor
Double-ridged wave guide horn antenna
Model 3115
Serial no: 9911-5964
(HL1984)

Frequency, MHz	Antenna factor. dB(1/m)
1000.0	24.7
1500.0	25.7
2000.0	27.6
2500.0	28.9
3000.0	31.2
3500.0	32.0
4000.0	32.5
4500.0	32.7
5000.0	33.6
5500.0	35.1
6000.0	35.4
6500.0	34.9
7000.0	36.1
7500.0	37.8
8000.0	38.0
8500.0	38.1
9000.0	39.1
9500.0	38.3
10000.0	38.6
10500.0	38.2
11000.0	38.7
11500.0	39.5
12000.0	40.0
12500.0	40.4
13000.0	40.5
13500.0	41.1
14000.0	41.6
14500.0	41.7
15000.0	38.7
15500.0	38.2
16000.0	38.8
16500.0	40.5
17000.0	42.5
17500.0	45.9
18000.0	49.4

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

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Cable, Coax, Microwave, DC-18 GHz, N-N, 1 m
Gore, model PFP01P01039.4 (HL 0410)
Calibration data

No.	Parameter	Set, GHz	Measured, dB	Deviation	Tolerance (Specification), dB	Meas. Uncert., dB
1	Insertion Loss	0.5	0.16	-	≤ 0.30	±0.12
2		1	0.28	-	≤ 0.39	
3		2	0.38	-	≤ 0.51	
4		4	0.55	-	≤ 0.70	
5		6	0.85	-	≤ 0.86	
6		8	0.90	-	≤ 1.01	±0.17
7		10	1.07	-	≤ 1.14	
8		12	1.11	-	≤ 1.25	
9		14	1.29	-	≤ 1.35	±0.26
10		16	1.41	-	≤ 1.46	
11		18	1.73	-	≤ 2.0 *	

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Cable Coaxial, GORE A2P01POL118, 2.3 m, model:GORE-3, s/n 176 (HL 0589)
+ Cable Coaxial, ANDREW PSWJ4, 6m, model: ANDREW-6, s/n 163 (HL 1004)
Calibration data

No.	Parameter	SET, MHz	Measured, dB	Deviation, dB	Tolerance (Specification), dB	Meas. Uncert., dB	Notes
1	Insertion Loss	30	0.33	-	≤ 6.5	±0.12	
2		50	0.40	-			
3		100	0.57	-			
4		300	0.97	-			
5		500	1.25	-			
6		800	1.59	-			
7		1000	1.81	-			
8		1200	1.97	-			
9		1400	2.15	-			
10		1600	2.28	-			
11		1800	2.43	-			
12		2000	2.61	-			
13		2200	2.75	-			
14		2400	2.89	-			
15		2600	2.97	-			
16	Insertion Loss	2800	3.21	-	≤ 6.5	±0.12	
17		3000	3.32	-			
18		3300	3.47	-			
19		3600	3.62	-			
20		3900	3.84	-			
21		4200	3.92	-		±0.17	
22		4500	4.07	-			
23		4800	4.36	-			
24		5100	4.62	-			
25		5400	4.78	-			
26		5700	5.16	-			
27		6000	5.67	-			
28		6500	5.99	-			

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Cable Coaxial , M17/164 , 10 m, model: C17164-10 (HL 1003),
Calibration data

No.	Parameter	SET, MHz	Measured, dB	Meas. Uncert., dB	Notes
1	Insertion Loss	30	0.34	±0.12	
2		50	0.47		
3		100	0.71		
4		300	1.41		
5		500	1.97		
6		800	2.68		
7		1000	3.1		
8		1200	3.57		
9		1400	3.9		
10		1600	4.28		
11		1800	4.65		
12		2000	5.01		
13		2200	5.34		
14		2400	5.68		
15		2600	6.05		
16		2800	6.44		
17		3000	6.81		
18		3300	7.28		
19		3600	7.69		
20		3900	8.1		

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Cable RF, 3.5 m,
Alpha Eire, model RG-14 (HL 1553)
Calibration data

No.	Parameter	SET		Measured, dBm	Attenuation, dB	Meas. Uncert., dB	Notes
		MHz	dBm				
1	Attenuation	1	-0.12	-0.13	0.01	±0.12	
2		10	0.00	-0.07	0.07		
3		30	-0.10	-0.22	0.12		
4		50	-0.09	-0.31	0.22		
5		100	-0.13	-0.39	0.26		
6		200	-0.08	-0.48	0.40		
7		300	-0.12	-0.64	0.52		
8		400	-0.03	-0.63	0.60		
9		500	0.19	-0.51	0.70		
10		600	0.05	-0.72	0.77		
11		700	-0.06	-0.90	0.84		
12		800	-0.01	-1.01	1.00		
13		900	0.03	-0.97	1.00		
14		1000	-0.08	-1.13	1.05		
15		2000	-0.19	-1.89	1.70		

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Cable RF, 2 m,
Huber-Suhner, model Sucoflex 104PE (HL 1566)
Calibration data

No.	Parameter	SET, MHz	Measured, dB	Deviation, dB	Meas. Uncert., dB	Notes
1	Insertion Loss	30	0.12	-	±0.12	
2		50	0.15	-		
3		100	0.22	-		
4		300	0.39	-		
5		500	0.52	-		
6		800	0.65	-		
7		1000	0.76	-		
8		1500	1.01	-		
9		2000	1.13	-		
10		2500	1.24	-		
11		3000	1.39	-		
12		3500	1.55	-		
13		4000	1.69	-		
14		4500	1.92	-	±0.17	
15		5000	1.92	-		
16		5500	2.05	-		
17		6000	2.21	-		
18		6500	2.28	-		
19		7000	2.39	-		
20		7500	2.67	-		

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Cable RF, 2 m,
Huber-Suhner, model Sucoflex 104PE (HL 1567)
Calibration data

No.	Parameter	SET, MHz	Measured, dB	Deviation, dB	Meas. Uncert., dB	Notes
1	Insertion Loss	30	0.13	-	±0.12	
2		50	0.16	-		
3		100	0.23	-		
4		300	0.39	-		
5		500	0.5	-		
6		800	0.64	-		
7		1000	0.74	-		
8		1500	0.88	-		
9		2000	1.04	-		
10		2500	1.16	-		
11		3000	1.32	-		
12		3500	1.42	-		
13		4000	1.55	-		
14		4500	1.73	-	±0.17	
15		5000	1.74	-		
16		5500	1.9	-		
17		6000	1.94	-		
18		6500	2.08	-		
19		7000	2.24	-		
20		7500	2.31	-		

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Cable RF, 8 m, model:RG-214, s/n C-56 (HL 2009)
Calibration data

No.	Parameter	SET, MHz	Measured, dB	Deviation	Tolerance (Specification)	Meas. Uncert., dB
1	Insertion Loss	1	0.10	NA	NA	±0.12
2		10	0.14			
3		30	0.25			
4		50	0.34			
5		100	0.53			
6		300	0.99			
7		500	1.31			
8		800	1.73			
9		1000	1.98			
10		1100	2.11			
11		1200	2.21			
12		1300	2.35			
13		1400	2.46			
14		1500	2.55			
15		1600	2.68			
16		1700	2.78			
17		1800	2.88			
18		1900	2.98			
19		2000	3.09			

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Appendix C Test equipment used for tests

HL Serial No.	Description	Manufacturer information			Due Calibr. Month/ year
		Name	Model No.	Serial No.	
0038	Antenna Mast, 1-4 m	Hermon Labs	AM-1	028	2/04 check
0091	Position controller for antenna mast + turntable, OFTS	Hermon Labs	CRL-2	91	4/04 check
0287	Turntable, motorized diameter, 2m	Hermon Labs	TMD-2	042	11/03 check
0410	Cable, Coax, Microwave, DC-18 GHz, N-N, 1 m	Gore	PFP01P0103 9.4	9338767	9/03
0446	Active Loop Antenna, 10 kHz-30 MHz	Electro-Mechanics	6502	2857	10/03
0465	Anechoic Chamber 9 (L) x 6.5 (W) x 5.5 (H) m	Hermon Labs	AC-1	023	10/05 check
0521	Spectrum Analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz)	Hewlett Packard	8546A	0319	9/03
0566	Antenna, Biconical, 20-200 MHz	Electro-Metrics	BIA 25/30	3566	11/03
0569	Antenna, Log Periodic, 200-1000MHz	Electro-Metrics	LPA 25/30	1953	1/04
0589	Cable Coaxial, GORE A2POL118.2, 3m	Hermon Labs	GORE-3	589	12/03
0604	Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz	EMCO	3141	9611-1011	01/04
1003	Cable coaxial, M17/164, 10 m	Hermon Labs	C17164-10	161	11/03
1004	Cable coaxial, ANDREW PSWJ4, 6 m	Hermon Labs	ANDREW-6	163	12/03
1200	Quadruplexer, 1-12 GHz	Elettronica S.p.A.-Roma	UE 84	0240	4/04 check
1424	Spectrum analyzer, 30 Hz - 40 GHz	Agilent Technologies	8564EC	3946A00219	8/03
1425	EMI Receiver System, 9 kHz - 2.9 GHz	Agilent Technologies	8542E	3710A00222	9/03
1430	EMI Receiver System, 9 kHz - 2.9 GHz	Agilent Technologies	8542E	3807A00262	9/03
1553	Cable RF, 3.5 m	Alpha wire	RG-214	1553	5/04
1566	Cable RF, 2 m	Huber-Suhner	Sucoflex 104PE	13094/4PE	12/03
1567	Cable RF, 2 m	Huber-Suhner	Sucoflex 104PE	13094/4PE	12/03
1650	Attenuators set (2, 3, 5, 20 dB), DC – 18 GHz	M/A –COM	2082	1650	03/04
1826	Antenna mast and turntable position controller	Sh. I. Machines	CRL-4	1	5/04 check
1849	Antenna mast with polarity control	Sh. I. Mashines	AM-F4	1849	1/04 check
1850	Turntable	Sh. I. Mashines	TT-M-3	1850	1/04 check
1942	Cable 18 GHz, 4 m, blue	Rhophase Microwave Ltd	SPS-1803A-4000-NPS	T4658	10/03
1984	Antenna, double ridged waveguide horn, 1-18 GHz, 300W, N-type	EMC Test Systems	3115	9911-5964	3/04
2009	Cable RF, 8 m	Alpha Wire	RG-214	C-56	12/03
2109	Anechoic chamber 6 (L) x 5.5 (W) x 2.95 (H) m	Hermon Labs	AC-2	2109	12/03 check
2259	Amplifier Low Noise 2-20 GHz	Sophia Wireless	LNA0220-C	0223	11/03

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Appendix D General information

Test facility description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private EMC, safety, environmental 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 TNO Certification EP&S (Netherlands) for a number of EMC, telecommunications, environmental, safety standards, and by AMTAC (UK) for safety of medical devices. The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing and environmental simulation (for exact scope please refer to Certificate No. 839.01) and approved by Israel Ministry of environmental protection, radiation hazards department (Permit number 1158).

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Abbreviations and acronyms

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

AC	alternating current
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
EUT	equipment under test
GHz	gigahertz
H	height
Hz	hertz
kHz	kilohertz
kV	kilovolt
L	length
LNA	low noise amplifier
m	meter
MHz	megahertz
NA	not applicable
QP	quasi-peak
P-to-MP	point-to-multipoint
P-to-P	point-to-point
RF	radio frequency
RE	radiated emission
rms	root mean square
s	second
V	volt
W	width

Specification references

47CFR part 15: 2002	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.