



HERMON LABORATORIES



Hermon Laboratories Ltd.
P.O.Box 23
Binyamina 30550, Israel
Tel. +972 46288001
Fax. +972 46288277
e-mail: mail@hermonlabs.com

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-DM

This report is in conformity with ISO/IEC 17025. The A2LA logo endorsement applies only to the test methods and the standards that are listed in the scope of Hermon Laboratories accreditation.
The test results relate only to the items tested. **This test report must not be reproduced in any form except in full with the approval of Hermon Laboratories Ltd.**



Contents

1	Project information.....	3
2	Summary of tests.....	4
3	EUT description	6
3.1	GENERAL DESCRIPTION	6
3.2	EUT TEST CONFIGURATION	6
3.3	EUT TECHNICAL CHARACTERISTICS.....	7
4	Test results.....	8
4.1	OCCUPIED BANDWIDTH FOR DSSS SYSTEMS ACCORDING TO § 15.247(A) (2).....	8
4.2	MAXIMUM PEAK OUTPUT POWER TEST ACCORDING TO §15.247 (B)(3)	9
4.3	OUT OF BAND CONDUCTED EMISSIONS TEST ACCORDING TO §15.247(C)	10
4.4	RADIATED EMISSIONS WHICH FALL IN RESTRICTED BANDS TEST ACCORDING TO §15.247(C) AND § 15.205, §15.209(A).....	11
4.5	PEAK POWER SPECTRAL DENSITY OF DSSS ACCORDING TO § 15.247(D)	12
4.6	UNINTENTIONAL RADIATED EMISSIONS TEST ACCORDING TO §15.109.....	13
	Appendix A Plots	14
	Appendix B Antenna factors and cable loss.....	50
	Appendix C Test equipment used for tests.....	57
	Appendix D General information.....	58
	TEST FACILITY DESCRIPTION	58
	ABBREVIATIONS AND ACRONYMS	58
	SPECIFICATION REFERENCES	58



1 Project information

Description of equipment under test

Test items	: TransMeter Water
Manufacturer	: Tadiran Telematics Ltd
Equipment serial number	: 03048130
Types (Models)	: TMW-DM
Equipment FCC code	: DSS

Applicant information

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

Test performance

Project Number:	: 15466
Location	: Hermon Laboratories
Receipt date	: March 03, 2003
Test performed	: March 03, 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



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	March 03, 2003	
Maximum peak output power	b(3)	C				Mr. Y. Neuman, test engineer	March 03, 2003	
Exposure compliance requirements	b(4)	C						
Spurious emissions (conducted)	c	C				Mr. Y. Neuman, test engineer	March 03, 2003	
Spurious emissions (radiated)	c			NT				
Spurious emissions (radiated) in restricted bands	15.209, 15.205 (a, c)	C				Mr. Y. Neuman, test engineer	March 03, 2003	
Peak power spectral density	d	C				Mr. Y. Neuman, test engineer	March 03, 2003	
Unintentional radiation, §15.107, §15.109								
Conducted emissions	15.107				NA			
Radiated emissions	15.109	C				Mr. Y. Neuman, test engineer	March 03, 2003	



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. Yu. Neuman, MSc, EMC group leader

Mr. E. Usoskin, PhD, CEO



3 EUT description

3.1 General description

The EUT, TMW-DM, is a water meter with a built-in 2-way RF communicator. The RF capabilities enable transmission of meter readings and some extra information to a collecting unit.

The TMW-DM comprises RF transmitter and receiver, which operate in ISM band (916.3 MHz), and a microcontroller, which controls the operational modes.

The device is intended for installation with antenna in horizontal position and is powered by two internal 3.6 V lithium batteries.

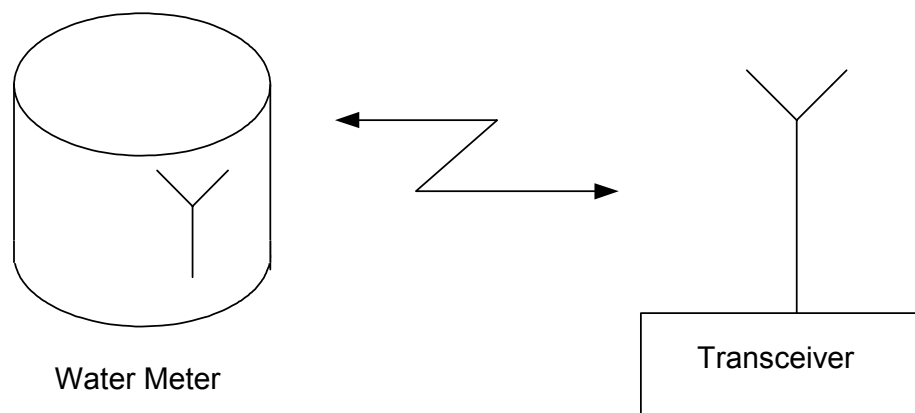
3.2 EUT test configuration

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 oscillator
852.33 MHz	Local oscillator
32.768 kHz	Clock
26.6353 MHz	Clock

Figure 3.2.1 EUT test configuration





3.3 EUT technical characteristics

Type of equipment				
☒	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)			
☒	Digitally modulated			
☐	Combined			
Spread spectrum parameters				
☒	chip sequence length (bits)	NA		
	spectrum width (MHz)	0.67 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)				14.5
Is transmitter output power variable?				
☒	No			
☐	Yes		continuous variable	
			stepped variable	
			stepsize :	
			minimum RF power :	
			maximum RF power :	
Transmitter power source				
☒	Battery	Nominal rated voltage (VDC)	3.6	
☒	Lithium			
☐	Other			
☐	DC	Nominal rated voltage		
☐	AC mains	Nominal rated voltage (VAC)		
Is there common power source for transmitter and receiver				☒ yes ☐ no
Antenna technical characteristics				
	Type	Manufacturer	Model number	Gain, dBi
	Integral with temporary RF connector	PIFA	Telematics	NA
External antenna connection - NA				



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:	March 3, 2003
RELATIVE HUMIDITY:	54 %
AMBIENT TEMPERATURE:	22°C
AIR PRESSURE:	1015 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	630	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 0521	HL 1650					
---------	---------	--	--	--	--	--



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

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.4
DATE:	March 3, 2003
RELATIVE HUMIDITY:	54 %
AMBIENT TEMPERATURE:	22°C
AIR PRESSURE:	1015 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	14.24	30	15.76	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 0521	HL 1650					
---------	---------	--	--	--	--	--



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

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.5
DATE:	March 3, 2003
RELATIVE HUMIDITY:	54 %
AMBIENT TEMPERATURE:	22°C
AIR PRESSURE:	1015 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. No spurious emissions except harmonics of fundamental were found. For test results refer to Plots A3 – A17.

Frequency, MHz	Resolution bandwidth, MHz	Spurious emission level, dB(μV)	Calculated limit, dB(μV)	Reference to Plots in Appendix A
1832.38	100 kHz	59.07	101	A3, A12
2748.88	100 kHz	57.45	101	A3, 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 0521	HL 1424	HL 1650			
---------	---------	---------	--	--	--



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:	March 3, 2003
RELATIVE HUMIDITY:	54 %
AMBIENT TEMPERATURE:	22°C
AIR PRESSURE:	1015 hPa
OPERATING FREQUENCY RANGE	902-928 MHz
MODULATION TECHNIQUE	Digitally modulated
BIT RATE:	60 kbps
FREQUENCY RANGE*	9 kHz – 9.2 GHz
Measurement uncertainty:	± 4.5 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
2748.9	54.85	74	19.15	A26

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
2748.9	29.65	54	24.35	A26

The recorded test result was obtained through measurements with double ridged guide antenna in vertical polarization.

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	A18, A19
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 3.5 ms as shown in Plots A18, A19.

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 horizontal. The loop center was 1 meter above the ground plane. To find maximum radiation the turntable was rotated 360°. Then the loop position was changed to vertical. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated about its vertical axis. Plots A20, A21 in Appendix A refer to vertical antenna polarization as the worst case.

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 0446	HL 0465	HL 0521	HL 0589	HL 0592	HL 0593	HL 0604	HL 1004
HL 1200	HL 1424	HL 1947	HL 1984	HL 2009	HL 2254	HL 2259	



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

DATE: March 3, 2003
RELATIVE HUMIDITY: 54 %
AMBIENT TEMPERATURE: 22°C
AIR PRESSURE: 1015 hPa
OPERATING FREQUENCY RANGE: 902 - 928 MHz
MODULATION TECHNIQUE: Digitally modulated
BIT RATE: 60 kbps
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	7.88	A31, A32

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 0521	HL 1650					
---------	---------	--	--	--	--	--



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: March 3, 2003
TEST PERFORMED AT: Anechoic chamber
AMBIENT TEMPERATURE: 22°C
RELATIVE HUMIDITY: 54%
DISTANCE BETWEEN ANTENNA AND EUT: 3 m
THE EUT WAS TESTED AS: Table-top
FREQUENCY 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 A33 – A36.

LIMIT (§ 15.109)

Frequency, MHz	Class B equipment @ 3 m dB(μ V/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°, 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 0521	HL 0589	HL 0592	HL 0593	HL 0604	HL 1004
HL 1947	HL 1984	HL 2009				



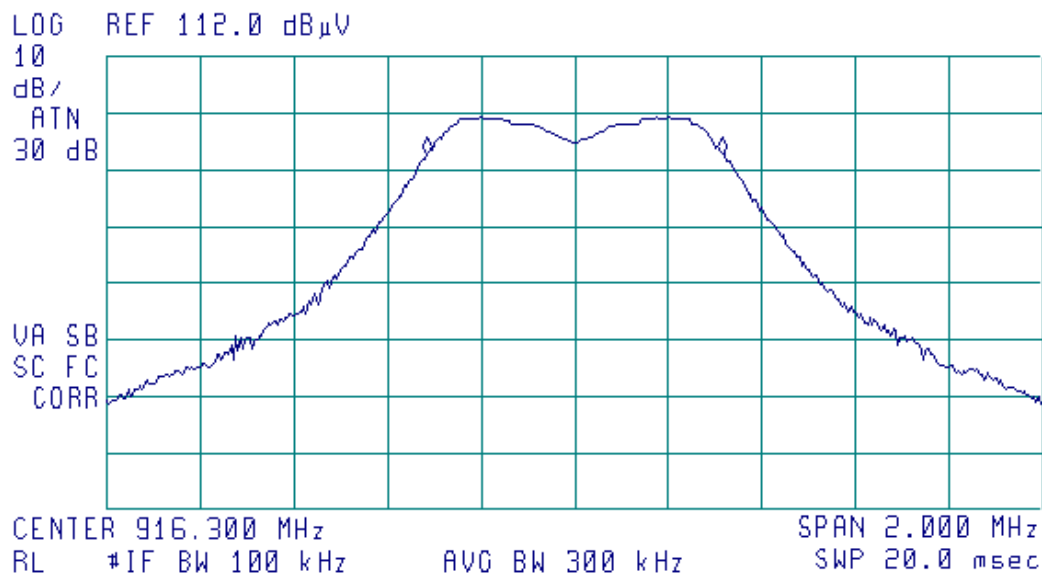
Appendix A Plots

Plot A 1

6 dB bandwidth @ 916.3 MHz

10:22:47 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR Δ 630 kHz
-.09 dB



External attenuator 20 dB

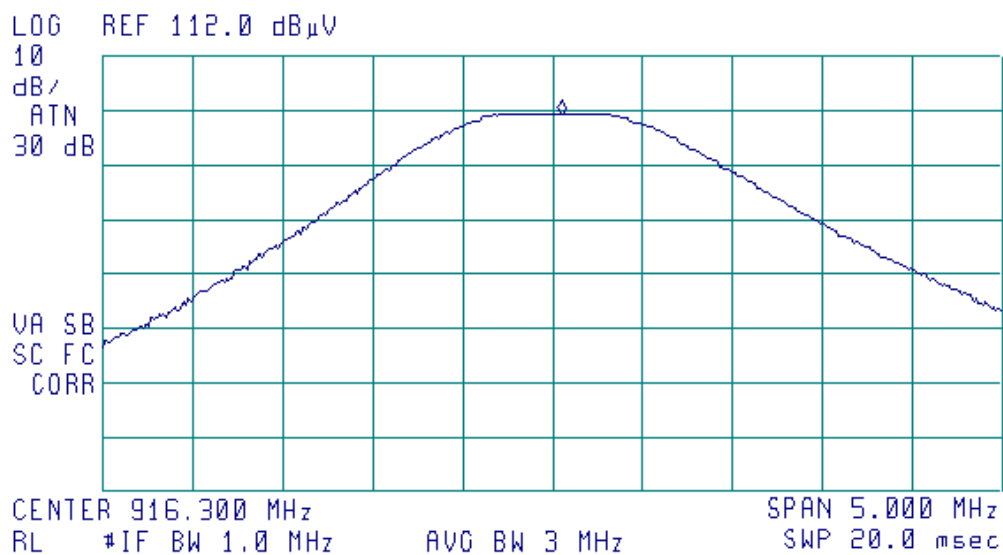


Plot A 2

Peak output power measurements@ 916.3 MHz

10:42:22 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 916.350 MHz
101.24 dBμV



External attenuator 20 dB

$$P_{out} = 101.24 \text{ dB}(\mu\text{V}) + 20 \text{ dB (ext.att.)} - 107 \text{ dB} = 14.24 \text{ dBm}$$



Plot A 3

In-band emission measurements @ 916.3 MHz carrier

10:25:25 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 916.100 MHz
100.94 dB μ V

LOG REF 112.0 dB μ V

10

dB/

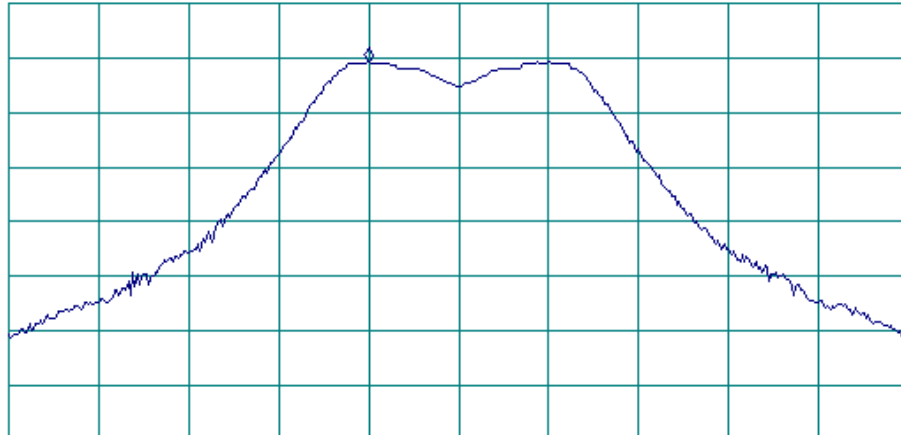
ATN

30 dB

VA SB

SC FC

CORR



CENTER 916.300 MHz

RL #IF BW 100 kHz

AVG BW 300 kHz

SPAN 2.000 MHz

SWP 20.0 msec

External attenuation 20 dB

The highest in-band emission level in 100 kHz bandwidth = 101 dB(μ V) (measured) + 20 dB (ext. att.) = 121 dB(μ V).

Conducted spurious emissions limit = 121 dB(μ V) – 20 dB (§15.247 (5) (c) requirement) = 101 dB(μ V)



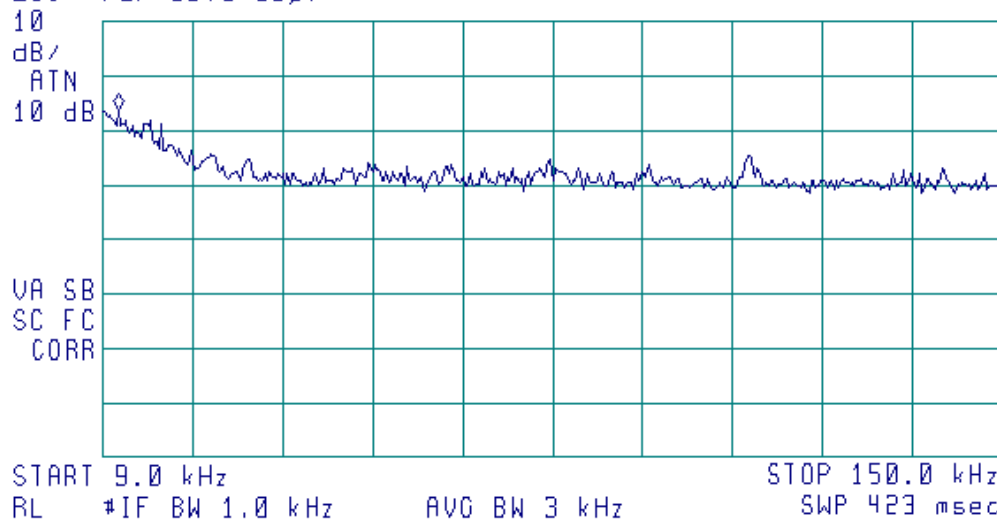
Plot A 4

Conducted spurious emission measurements in 9 kHz – 150 kHz

11:35:56 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 11.5 kHz
5.83 dB μ V

LOG REF 22.0 dB μ V



External attenuation 20 dB.
No spurious emissions were found.



Plot A 5

Conducted spurious emission measurements in 150 kHz – 1 MHz

11:33:02 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 385.9 kHz
5.71 dB μ V

LOG REF 22.0 dB μ V

10
dB/
ATN
10 dB

VA SB
SC FC
CORR

START 150.0 kHz

RL #IF BW 10 kHz

AVG BW 30 kHz

STOP 1.0000 MHz

SWP 30.0 msec

External attenuation 20 dB.
No spurious emissions were found.



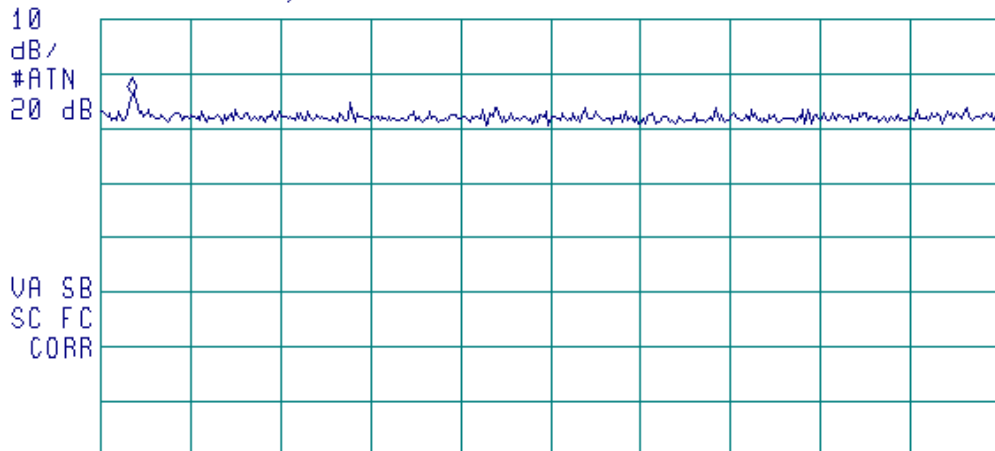
Plot A 6

Conducted spurious emission measurements in 1 MHz – 30 MHz

11:30:52 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.02 MHz
28.22 dB μ V

LOG REF 42.0 dB μ V



START 1.00 MHz STOP 30.00 MHz
RL #IF BW 100 kHz AVG BW 300 kHz SWP 20.0 msec

External attenuation 20 dB.
No spurious emissions were found.



Plot A 7

Conducted spurious emission measurements in 30 MHz – 200 MHz

11:27:42 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 123.9 MHz
26.99 dB μ V

LOG REF 42.0 dB μ V

10

dB/

#ATN

20 dB

VA SB

SC FC

CORR

START 30.0 MHz

RL #IF BW 100 kHz

AVG BW 300 kHz

STOP 200.0 MHz

SWP 51.0 msec

External attenuation 20 dB.
No spurious emissions were found.



Plot A 8

Conducted spurious emission measurements in 200 MHz – 916 MHz

11:22:54 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 677.9 MHz
28.28 dB μ V

LOG REF 42.0 dB μ V

10

dB/

#ATN

20 dB

VA SB

SC FC

CORR

START 200.0 MHz

RL #IF BW 100 kHz

AVG BW 300 kHz

STOP 916.0 MHz

SWP 215 msec

External attenuation 20 dB.
No spurious emissions were found.



Plot A 9

Conducted spurious emission measurements in 900 MHz – 902 MHz

11:42:19 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 901.150 MHz
30.76 dB μ V

LOG REF 42.0 dB μ V

10

dB/

#ATN

20 dB

VA SB

SC FC

CORR

START 900.000 MHz

RL #IF BW 100 kHz

AVG BW 300 kHz

STOP 902.000 MHz

SWP 20.0 msec

External attenuation 20 dB.
No spurious emissions were found.



Plot A 10

Conducted spurious emission measurements in 928 MHz – 1000 MHz

11:44:31 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 939.88 MHz
28.71 dB μ V

LOG REF 42.0 dB μ V

10

dB/

#ATN

20 dB

VA SB

SC FC

CORR

START 928.00 MHz

RL #IF BW 100 kHz

AVG BW 300 kHz

STOP 1.00000 GHz

SWP 21.6 msec

External attenuation 20 dB.
No spurious emissions were found.



Plot A 11

Conducted spurious emission measurements in 1000 MHz – 2000 MHz

11:46:45 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 1.835 GHz
37.55 dB μ V

LOG REF 42.0 dB μ V

10

dB/

#ATN

20 dB

VA SB

SC FC

CORR

START 1.000 GHz

RL #IF BW 100 kHz

AVG BW 300 kHz

STOP 2.000 GHz

SWP 300 msec

External attenuation 20 dB.

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



Plot A 12

Conducted spurious emission measurements,
center 1832.3 MHz

11:49:50 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 1.83228 GHz
39.07 dB μ V

LOG REF 52.0 dB μ V

10

dB/

#ATN

20 dB

VA SB

SC FC

CORR

CENTER 1.83238 GHz

RL #IF BW 100 kHz

AVG BW 300 kHz

SPAN 10.00 MHz

SWP 20.0 msec

The 2nd harmonic of the fundamental : 39.07 dB(μ V) (measured) + 20 dB (ext. att.) = 59.07 dB(μ V).

Conducted spurious emissions limit = 101 dB(μ V)

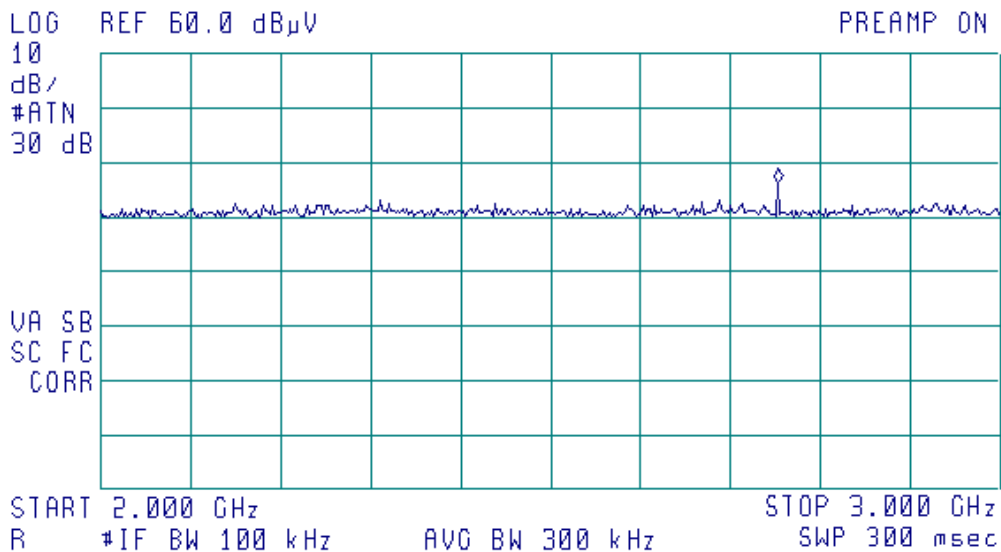


Plot A 13

Conducted spurious emission measurements in 2000 MHz – 3000 MHz

11:55:12 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.754 GHz
36.11 dB μ V



External attenuation 20 dB.

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

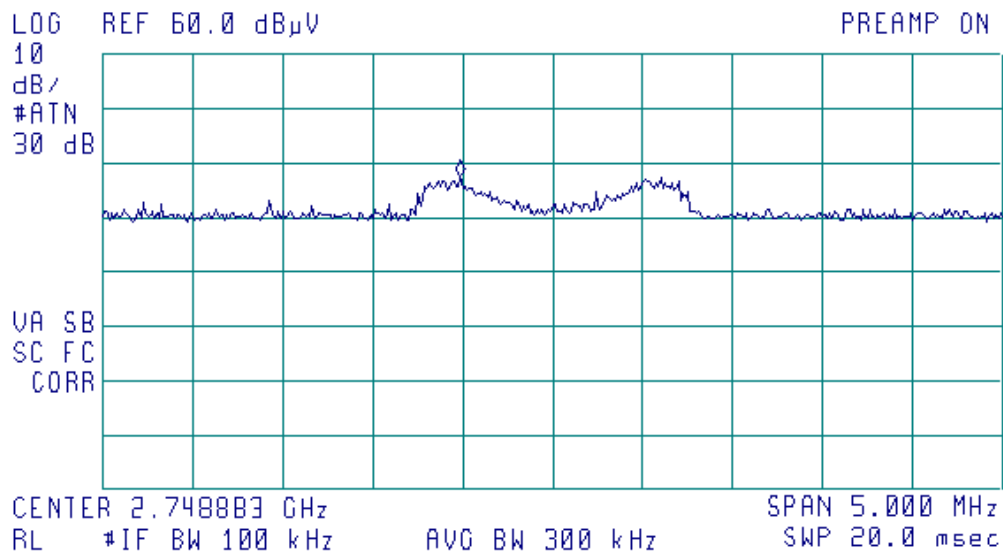


Plot A 14

Conducted spurious emission measurements,
center 2748.88 MHz

11:57:28 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.748370 GHz
37.45 dB μ V



The 3rd harmonic of the fundamental : 37.45 dB(μ V) (measured) + 20 dB (ext. att.) = 57.45 dB(μ V).

Conducted spurious emissions limit = 101 dB(μ V)



Plot A 15

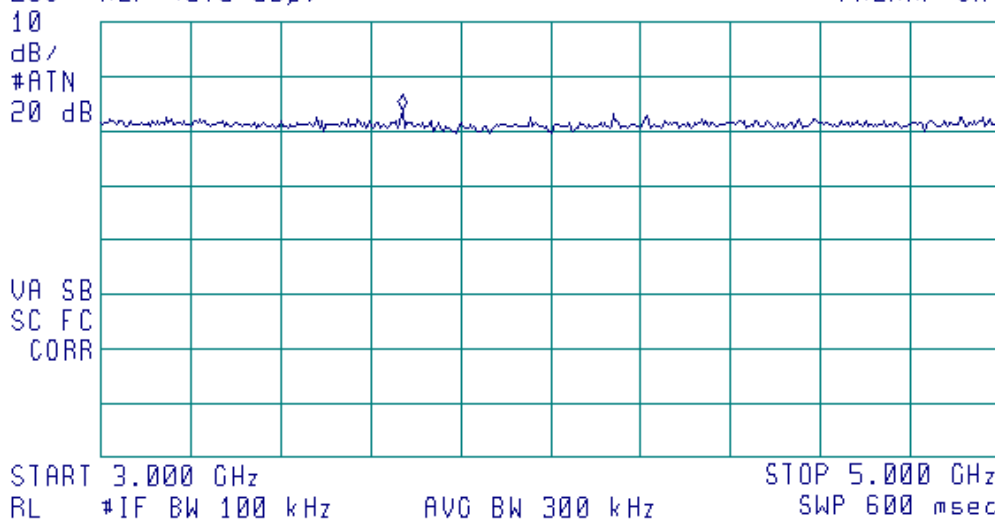
Conducted spurious emission measurements in 3000 MHz – 5000 MHz

12:03:17 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 3.670 GHz
23.72 dB μ V

LOG REF 40.0 dB μ V

PREAMP ON



External attenuation 20 dB.
No spurious emissions were found.

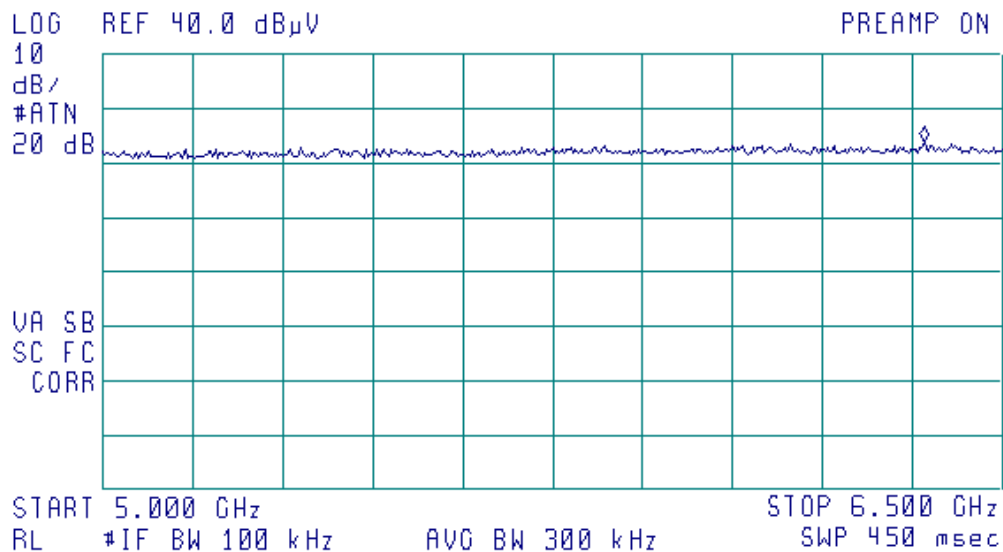


Plot A 16

Conducted spurious emission measurements in 5000 MHz – 6500 MHz

12:06:33 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 6.369 GHz
23.69 dB μ V

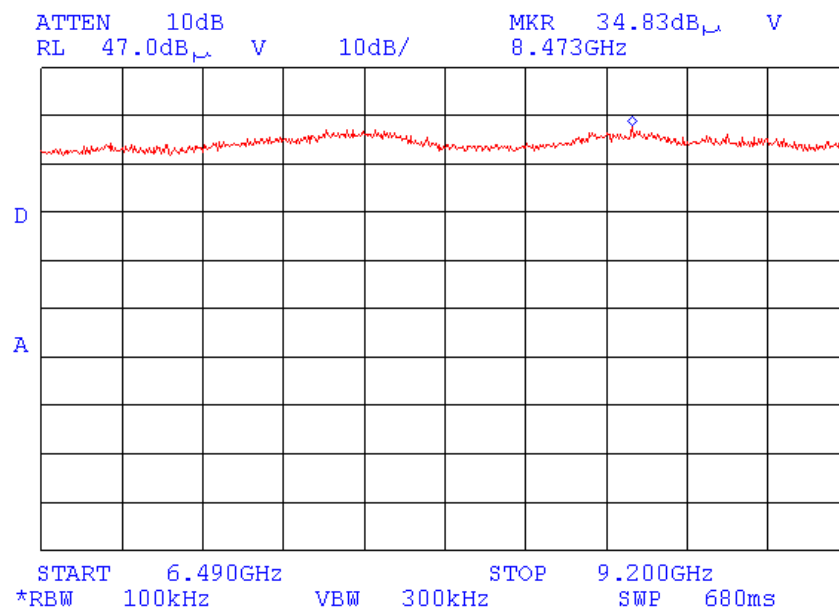


External attenuation 20 dB.
No spurious emissions were found.



Plot A 17

Conducted spurious emission measurements in 6490 MHz – 9200 MHz

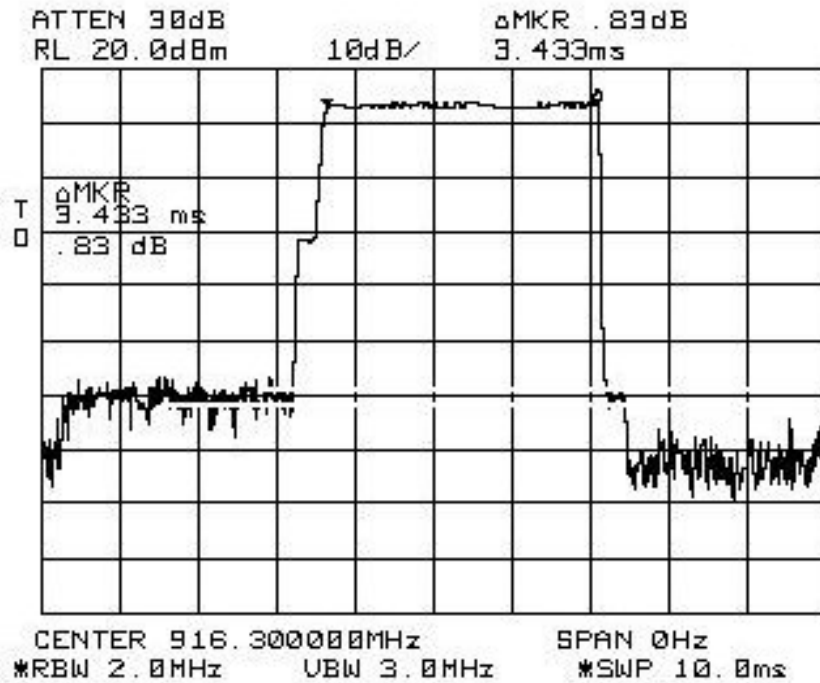


External attenuation 20 dB.
No spurious emissions were found.



Plot A 18

One transmission duration

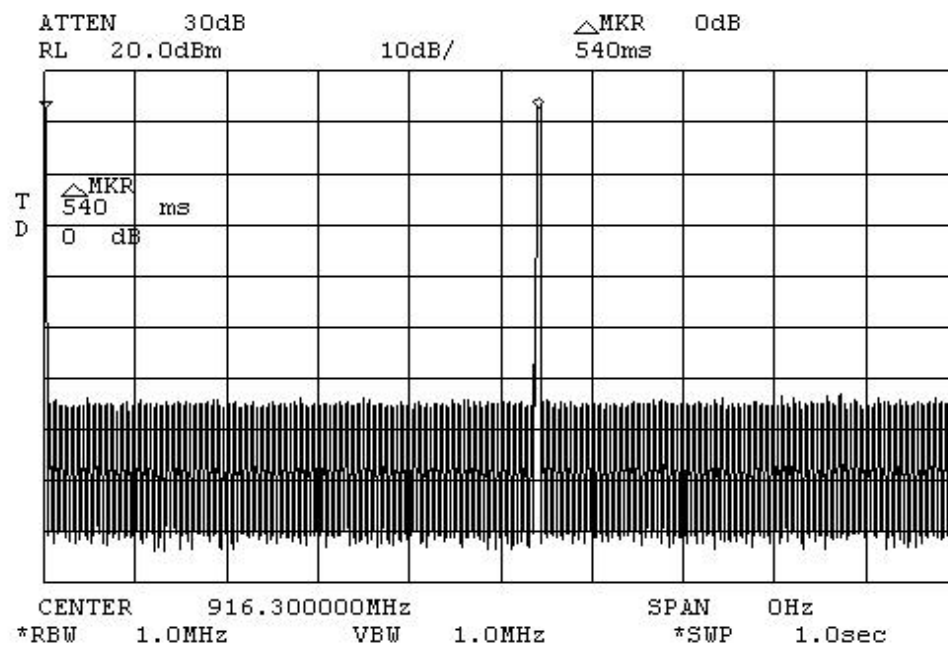


One transmission duration = 3.43 ms



Plot A 19

Interval between two successive transmissions



The interval between two successive transmissions = 540 ms



Plot A 20

Radiated spurious emission measurements in 9 kHz – 150 kHz

16:07:14 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 10.8 kHz
63.25 dB μ V/m

LOG REF 129.0 dB μ V/m

10
dB/
ATN
50 dB

VA SB
SC FC
ACORR

START 9.0 kHz STOP 150.0 kHz
R #IF BW 200 Hz AVG BW 300 Hz SWP 10.3 sec

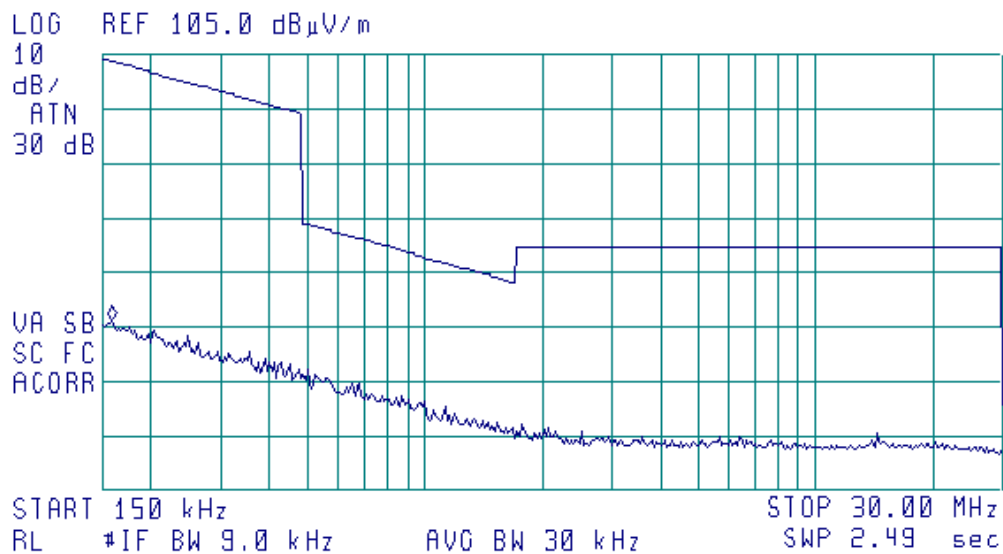


Plot A 21

Radiated spurious emission measurements in 150 kHz – 30 MHz

16:03:47 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 160 kHz
56.11 dB μ V/m



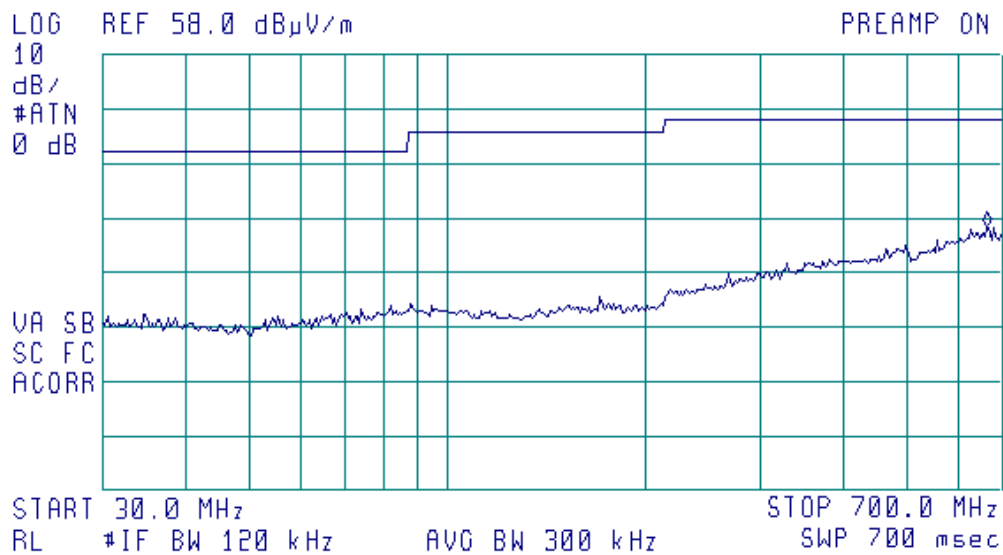


Plot A 22

Radiated spurious emission measurements in 30 MHz – 700 MHz

16:20:17 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 657.8 MHz
26.22 dB μ V/m



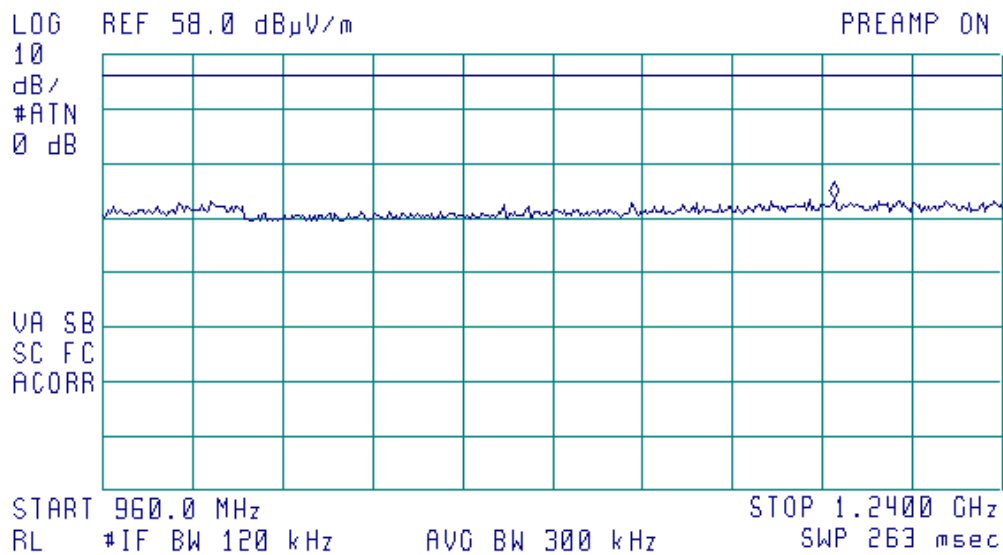


Plot A 23

Radiated spurious emission measurements in 960 MHz – 1240 MHz

16:26:56 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 1.1875 GHz
31.49 dB μ V/m



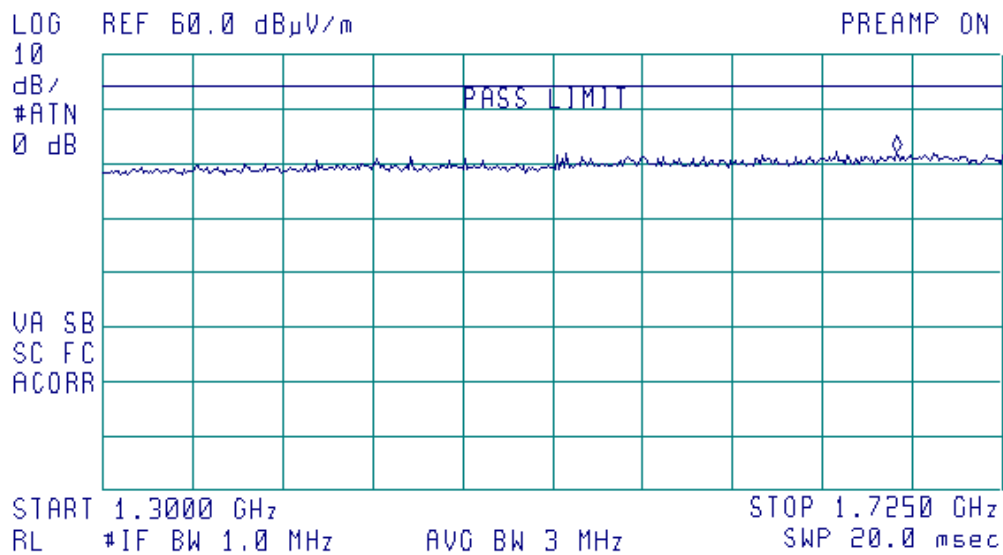


Plot A 24

Radiated spurious emission measurements in 1300 MHz - 1725 MHz

14:28:10 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 1.6751 GHz
42.13 dB μ V/m



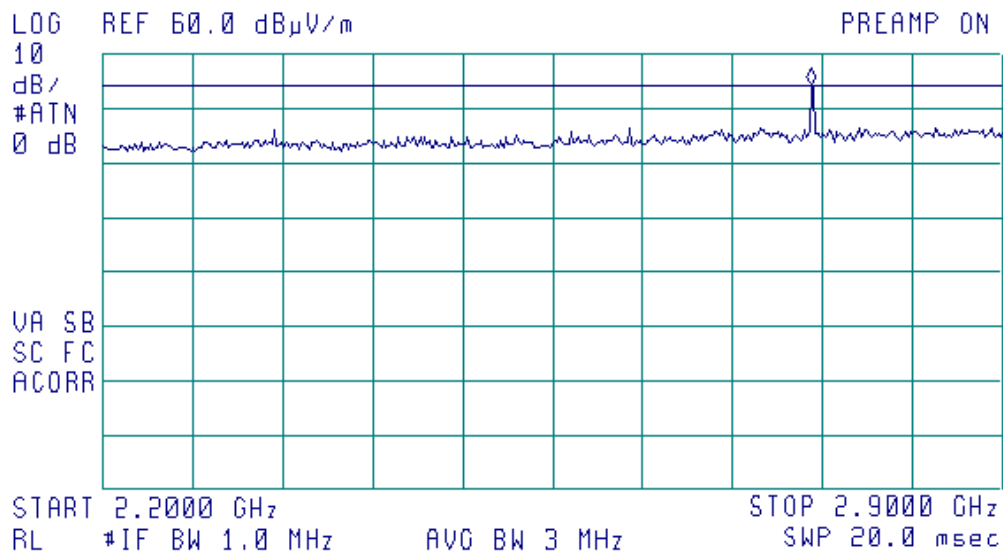


Plot A 25

Radiated spurious emission measurements in 2200 MHz – 2900 MHz

14:59:13 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 2.7513 GHz
54.50 dB μ V/m



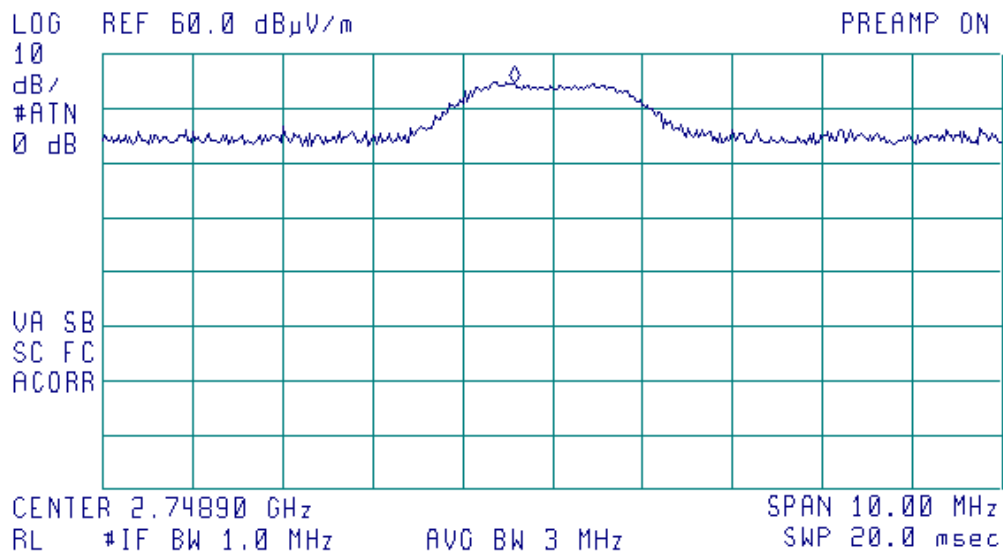


Plot A 26

Radiated spurious emission measurements,
center 2748.9 MHz

14:43:08 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 2.74848 GHz
54.85 dB μ V/m



The 3rd harmonic of fundamental.

Peak value=54.85 dB μ V/m

Limit for peak measurement =74 dB μ V/m

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

Average value=54.85 dB μ V/m – 25.2 dB=29.65 dB μ V/m

Limit for average measurement =54 dB μ V/m

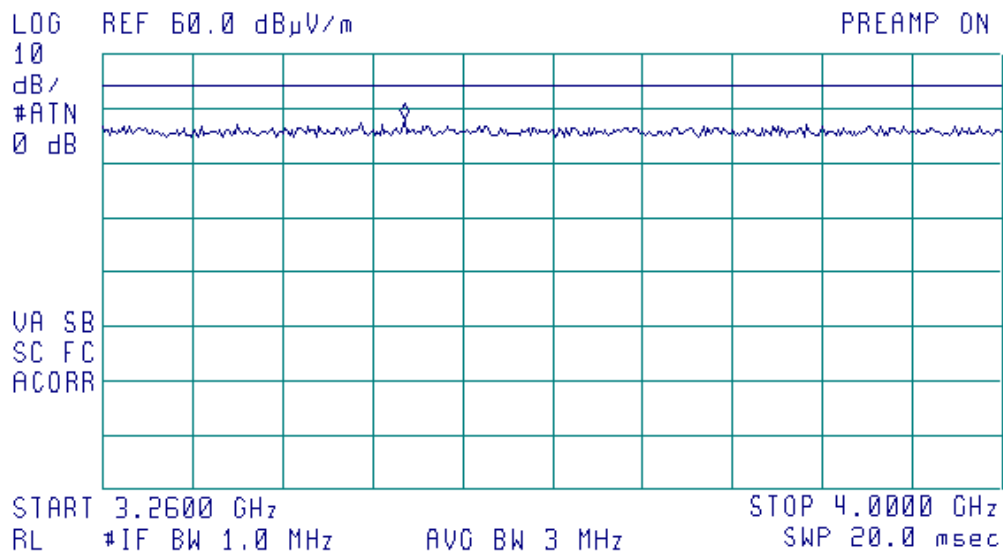


Plot A 27

Radiated spurious emission measurements in 3260 MHz – 4000 MHz

15:05:36 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 3.5079 GHz
47.99 dB μ V/m



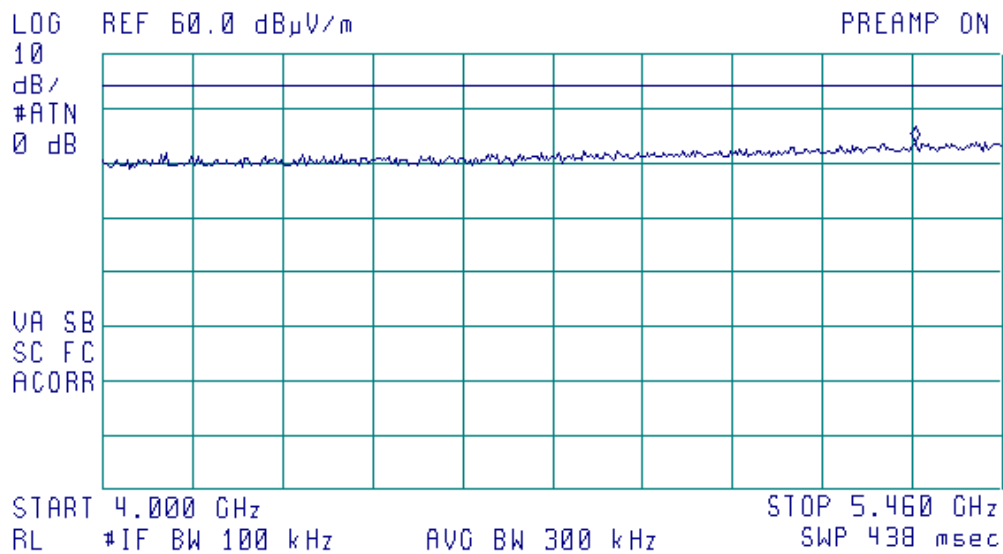


Plot A 28

Radiated spurious emission measurements in 4000 MHz – 5460 MHz

15:13:23 MAR 04, 2003

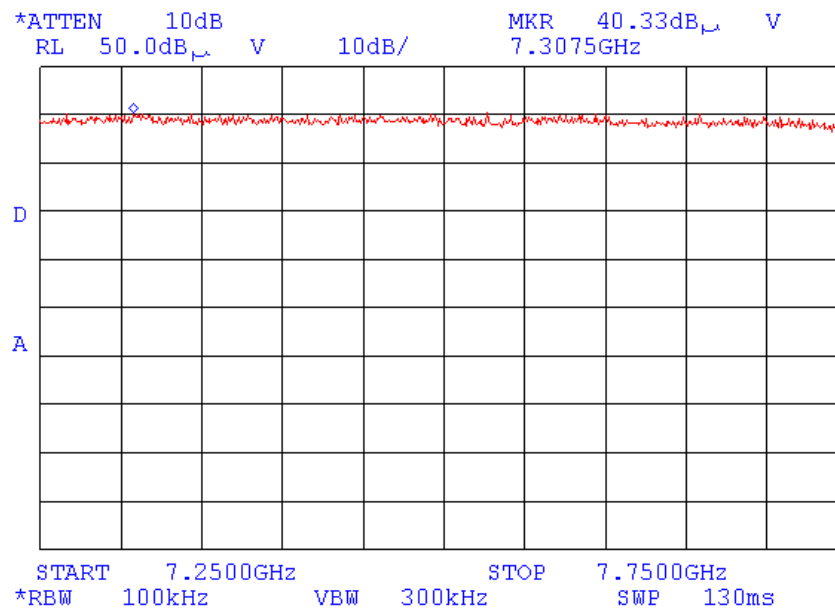
ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 5.318 GHz
43.80 dB μ V/m





Plot A 29

Radiated spurious emission measurements in 7250 MHz – 7750 MHz



External LNA = 39 dB

Noise level:

$$E = 40.33 \text{ dB}(\mu\text{V}) - 39 \text{ dB (LNA)} + 5.6 \text{ dB (CL)} + 38.0 \text{ dB (AF)} = 44.9 \text{ dB}(\mu\text{V/m})$$

Abbreviations:

LNA = low noise amplifier

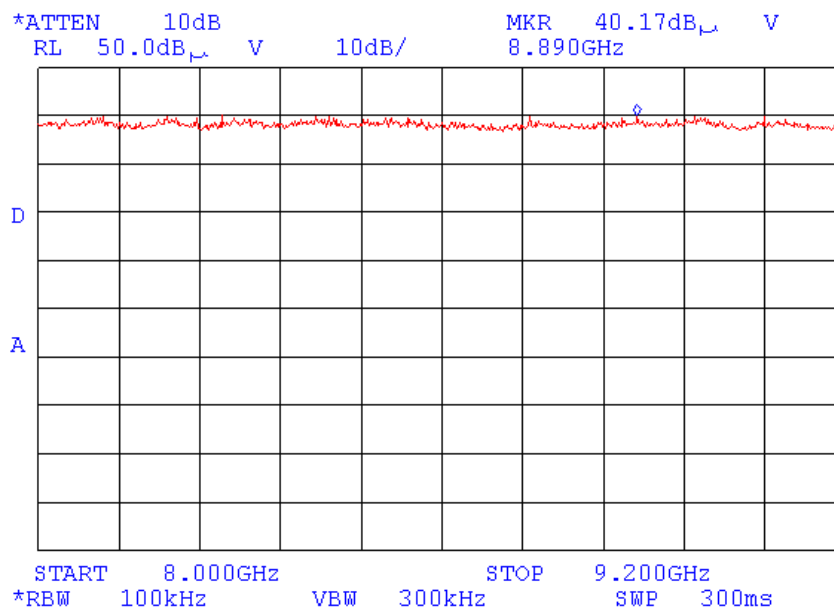
CL = cable loss

AF = antenna factor



Plot A 30

Radiated spurious emission measurements in 8000 MHz – 9200 MHz



External LNA = 38 dB

Noise level:

$$E = 40.17 \text{ dB}(\mu\text{V}) - 38 \text{ dB (LNA)} + 6.1 \text{ dB (CL)} + 39.1 \text{ dB (AF)} = 47.4 \text{ dB}(\mu\text{V/m})$$

Abbreviations:

LNA = low noise amplifier

CL = cable loss

AF = antenna factor



Plot A 31

Peak power spectral density measurements

10:52:05 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 916.415 MHz
94.81 dBμV

LOG REF 112.0 dBμV

10

dB/

ATN

30 dB

VA SB

SC FC

CORR

CENTER 916.300 MHz

RL #IF BW 3.0 kHz

AVG BW 10 kHz

SPAN 1.000 MHz

SWP 333 msec

External attenuator 20 dB



Plot A 32

Peak power spectral density measurements

11:06:54 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 916.41253 MHz
94.88 dBμV

LOG REF 112.0 dBμV

10

dB/

ATN

30 dB

VA SB

SC FC

CORR

CENTER 916.41275 MHz

RL #IF BW 3.0 kHz

AVG BW 10 kHz

SPAN 90.00 kHz

#SWP 30.0 sec

External attenuator 20 dB

Power density = 94.88 dB(μV) + 20 dB (ext.att.) - 107 dB = 7.88 dBm

The specified limit = 8 dBm

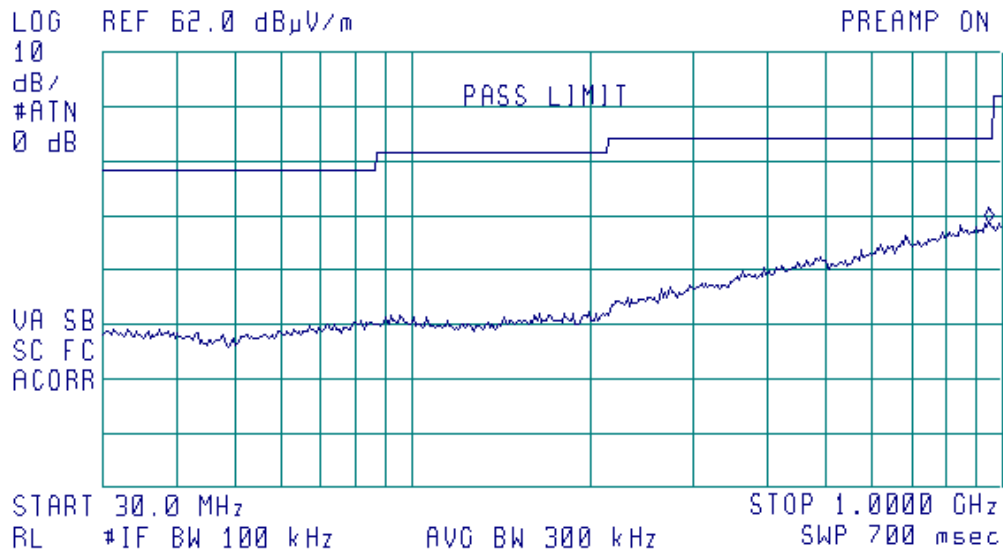


Plot A 33

Unintentional radiated emission measurements in 30 MHz – 1000 MHz

13:30:04 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 942.8 MHz
30.49 dB μ V/m



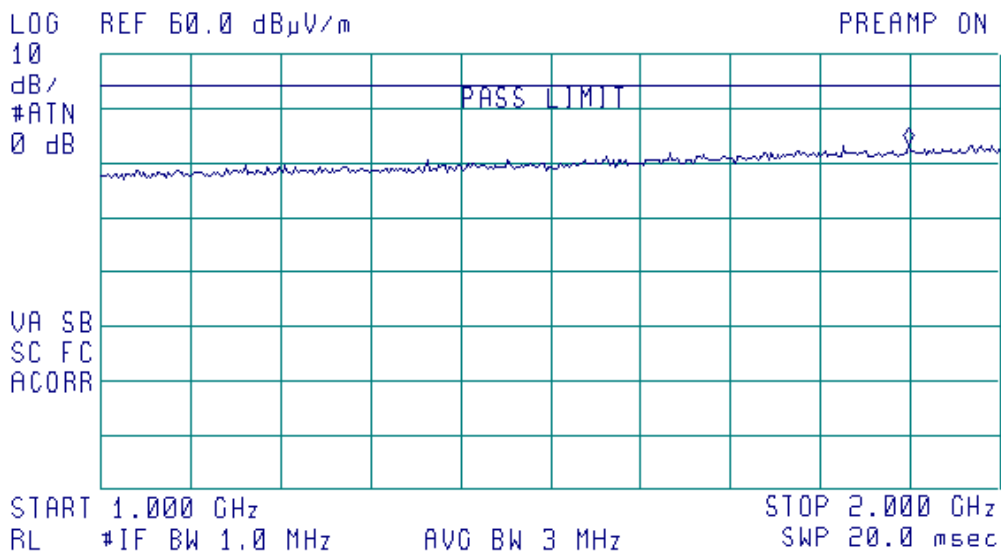


Plot A 34

Unintentional radiated emission measurements in 1000 MHz – 2000 MHz

13:59:14 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK OP AVG
MKR 1.898 GHz
43.62 dB μ V/m



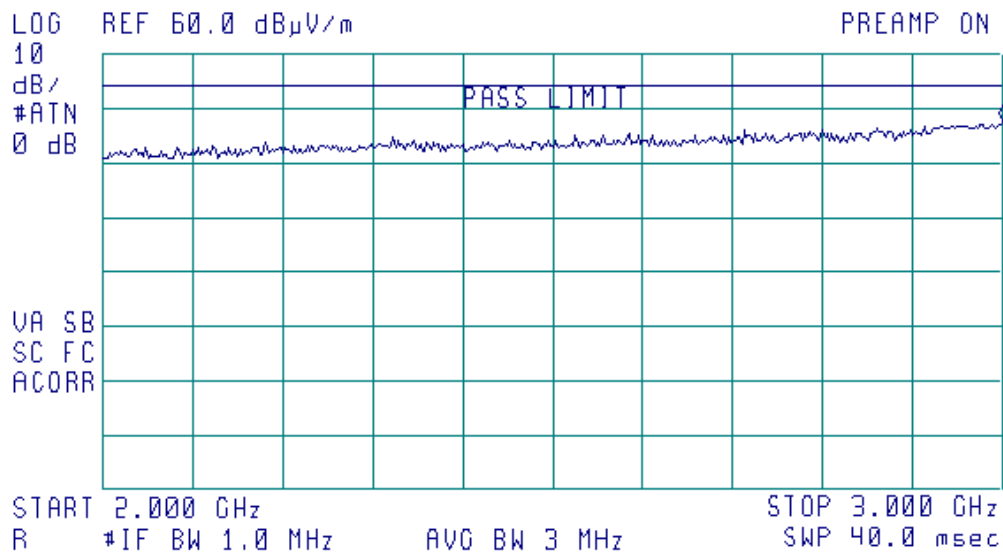


Plot A 35

Unintentional radiated emission measurements in 2000 MHz – 3000 MHz

14:02:05 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 3.000 GHz
47.77 dB μ V/m



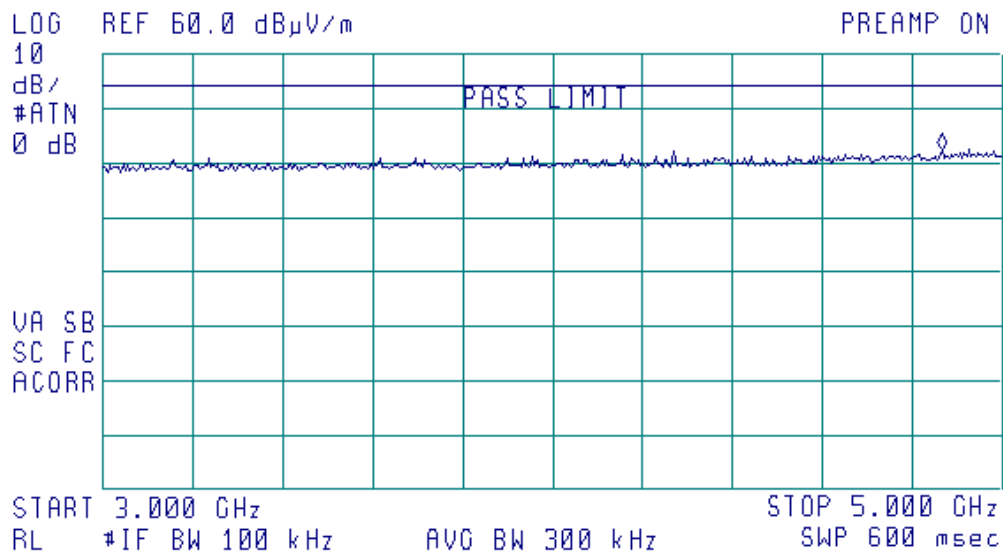


Plot A 36

Unintentional radiated emission measurements in 3000 MHz – 5000 MHz

14:06:51 MAR 04, 2003

ACTV DET: PEAK
MEAS DET: PEAK QP AVG
MKR 4.865 GHz
42.28 dB μ V/m





Appendix B Antenna factors and cable loss

**Antenna Factor
Active Loop Antenna
Model 6502
S/N 2857**

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(μ V) to convert it to field intensity in dB(μ V/m)



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(μ V) to convert it to field intensity in dB(μ V/m).



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(μ V) to convert it into field intensity in dB(μ V/m).



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	-			



Cable 18GHz, 6.5 m, blue, model: NPS-1803A-6500-NPS, s/n T4974 (HL 1947)
Calibration data

Frequency, GHz	Insertion Loss, dB
	HL1947
0.03	0.30
0.05	0.38
0.10	0.53
0.20	0.74
0.30	0.91
0.40	1.05
0.50	1.18
0.60	1.29
0.70	1.40
0.80	1.50
0.90	1.59
1.00	1.68
1.10	1.77
1.20	1.86
1.30	1.94
1.40	2.01
1.50	2.08
1.60	2.16
1.70	2.22
1.80	2.29
1.90	2.36
2.00	2.42
2.10	2.48
2.20	2.54
2.30	2.60
2.40	2.66
2.50	2.71
2.60	2.77
2.70	2.83
2.80	2.89
2.90	2.95
3.10	3.06
3.30	3.17
3.50	3.28
3.70	3.39
3.90	3.51
4.10	3.62
4.30	3.76
4.50	3.87
4.70	4.01
4.90	4.10
5.10	4.21
5.30	4.31
5.50	4.43
5.70	4.56
5.90	4.71

Frequency, GHz	Insertion Loss, dB
	HL1947
6.10	4.87
6.30	4.95
6.50	4.94
6.70	4.88
6.90	4.87
7.10	4.83
7.30	4.85
7.50	4.86
7.70	4.91
7.90	4.96
8.10	5.03
8.30	5.08
8.50	5.13
8.70	5.21
8.90	5.22
9.10	5.34
9.30	5.35
9.50	5.52
9.70	5.51
9.90	5.66
10.10	5.70
10.30	5.78
10.50	5.79
10.70	5.82
10.90	5.86
11.10	5.94
11.30	6.06
11.50	6.21
11.70	6.44
11.90	6.61
12.10	6.76
12.40	6.68
13.00	6.66
13.50	6.81
14.00	6.90
14.50	6.90
15.00	6.97
15.50	7.17
16.00	7.28
16.50	7.27
17.00	7.38
17.50	7.68
18.00	7.92



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			



Cable loss
Cable 40 GHz, 0.8 m, blue, model: KPS-1503A-800-KPS, S/N W4907, HL 2254

Frequency, GHz	Cable loss, dB	Frequency, GHz	Cable loss, dB	Frequency, GHz	Cable loss, dB
0.03	0.04	5.10	0.80	15.00	1.49
0.05	0.07	5.30	0.83	15.50	1.49
0.10	0.09	5.50	0.83	16.00	1.46
0.20	0.15	5.70	0.84	16.50	1.47
0.30	0.19	5.90	0.87	17.00	1.50
0.40	0.25	6.10	0.86	17.50	1.57
0.50	0.29	6.30	0.89	18.00	1.63
0.60	0.33	6.50	0.90	18.50	1.57
0.70	0.37	6.70	0.89	19.00	1.63
0.80	0.41	6.90	0.93	19.50	1.65
0.90	0.44	7.10	0.92	20.00	1.64
1.00	0.45	7.30	0.95	20.50	1.75
1.10	0.48	7.50	0.96	21.00	1.72
1.20	0.51	7.70	0.97	21.50	1.78
1.30	0.53	7.90	1.01	22.00	1.76
1.40	0.54	8.10	1.00	22.50	1.72
1.50	0.57	8.30	1.05	23.00	1.83
1.60	0.59	8.50	1.04	23.50	1.80
1.70	0.04	8.70	1.07	24.00	1.90
1.80	0.07	8.90	1.11	24.50	1.81
1.90	0.09	9.10	1.09	25.00	1.98
2.00	0.15	9.30	1.14	25.50	1.91
2.10	0.19	9.50	1.12	26.00	2.02
2.20	0.25	9.70	1.15	26.50	1.92
2.30	0.29	9.90	1.16	27.00	1.97
2.40	0.33	10.10	1.16	28.00	2.02
2.50	0.37	10.30	1.19	29.00	1.95
2.60	0.41	10.50	1.14	30.00	1.94
2.70	0.44	10.70	1.19	31.00	2.11
2.80	0.45	10.90	1.17	32.00	2.17
2.90	0.48	11.10	1.13	33.00	2.27
3.10	0.61	11.30	1.20	34.00	2.27
3.30	0.64	11.50	1.13	35.00	2.29
3.50	0.65	11.70	1.20	36.00	2.35
3.70	0.68	11.90	1.18	37.00	2.37
3.90	0.69	12.10	1.14	38.00	2.40
4.10	0.71	12.40	1.19	39.00	2.57
4.30	0.73	13.00	1.34	40.00	2.36
4.50	0.75	13.50	1.33		
4.70	0.77	14.00	1.48		
4.90	0.79	14.50	1.45		



Appendix C Test equipment used for tests

HL Serial No.	Description	Manufacturer information			Due Calibr. Month/ year
		Name	Model No.	Serial No.	
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
0589	Cable Coaxial, GORE A2POL118.2, 3m	Hermon Labs	GORE-3	589	12/03
0592	Position controller	Hermon Labs	L2-SR3000	100	5/03 check
0593	Antenna Mast, 1-4 m/ 1-6 m Pneumatic	Hermon Labs	AM-F1	101	2/04 check
0604	Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz	EMCO	3141	9611-1011	01/04
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	4/03 check
1424	Spectrum analyzer, 30 Hz - 40 GHz	Agilent Technologies	8564EC	3946A00219	8/03
1650	Attenuators set (2, 3, 5, 20 dB), DC – 18 GHz	M/A –COM	2082	1650	03/04
1947	Cable 18 GHz, 6.5 m, blue	Rhophase Microwave Ltd	NPS-1803A- 6500-NPS	T4974	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
2254	Cable 40 GHz, 0.8 m, blue	Rhophase Microwave	KPS-1503A- 800-KPS	W4907	11/03
2259	Amplifier Low Noise 2-20 GHz	Sophia Wireless	LNA0220-C	0223	11/03



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).

Address: PO Box 23, Binyamina 30550, Israel.

Telephone: +972 4628 8001

Fax: +972 4628 8277

e-mail: mail@hermonlabs.com

website: www.hermonlabs.com

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

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(μ V)	decibel referred to one microvolt
dB(μ V/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.