



HERMON LABORATORIES



Electrical

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## **RADIO TEST REPORT**

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

**Tadiran Telematics Ltd.**

EQUIPMENT UNDER TEST:

**TransMeter Water**

model: 250FH

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.**

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Document ID: TADRAD\_FCC.15187.doc  
Date of Issue: July 2002



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## 1 Project information

### Description of equipment under test

Test items : TransMeter Water  
Manufacturer : Tadiran-Telematics Ltd  
Equipment serial number : 001188  
Types (Models) : 250FH  
Hardware revision : A1  
Software revision : A1  
Equipment FCC code<sup>1</sup> : DSS

### Applicant information

Applicant's responsible person : Mr. Uzi Erman  
Company : Tadiran-Telematics Ltd  
Address : 26 Hamelaha St.  
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### Test performance

Project Number: : 15187  
Location : Hermon Laboratories  
Receipt date : July 9, 2002  
Test performed : July 9, 2002  
Purpose of test : Apparatus compliance verification in accordance with emission requirements  
Test specification(s) : 47CFR Part 15, §15.247 and subpart B

<sup>1</sup> FCC Equipment codes – see Appendix D



## 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, §15.247 and subpart B.

Parameter	Subclause	C	NC	NT	NA	Tested by	Date tested	Remarks
<b>Transmitter characteristics, §15.247</b>								
<b>Frequency hopping systems</b>								
Occupied bandwidth of hopping channels	(a)(1) (i – iii)	X				Mrs. E. Pitt, test engineer	July 9, 2002	
Hopping channel frequency separation	(a)(1)	X				Mrs. E. Pitt, test engineer	July 9, 2002	
Number of hopping channels	(a)(1) (i – iii)	X				Mrs. E. Pitt, test engineer	July 9, 2002	
Average time of occupancy	(a)(1) (i – iii)	X				Mrs. E. Pitt, test engineer	July 9, 2002	
Maximum peak output power	b(1), b(2), b(3)	X				Mrs. E. Pitt, test engineer	July 9, 2002	
Exposure compliance requirements	b(4)	X						Evaluation
Spurious emissions (conducted)	c				X			
Spurious emissions (radiated)	c	X				Mrs. E. Pitt, test engineer	July 9, 2002	
Spurious emissions (radiated) in restricted bands	15.209, 15.205(a,c)	X				Mrs. E. Pitt, test engineer	July 9, 2002	
<b>Direct sequence systems - NA</b>								
Minimum 6 dB bandwidth	a(2)							
Maximum peak output power	b(1)							
Exposure compliance requirements	b(4)							
Spurious emissions (conducted)	c							
Spurious emissions (radiated)	c							
Spurious emissions (radiated) in restricted bands	15.209, 15.205(a,c)							



Parameter	Subclause	C	NC	NT	NA	Tested by	Date tested	Remarks
Peak power spectral density	d							
Processing gain	e(2)							
<b>Hybrid systems - NA</b>								
Processing gain from the combined techniques	f							
Average time of occupancy at direct sequence operation turned off	f							
Peak power spectral density at frequency hopping operation turned off:	f							
Maximum peak output power	b (1) – (3)							
Exposure compliance requirements	b(4)							
Spurious emissions (conducted)	c							
Spurious emissions (radiated)	c							
Spurious emissions (radiated) in restricted bands	c, 15.209, 15.205(a,c)							
<b>Unintentional radiation, §15.107, §15.109</b>								
Conducted emissions	15.107				X			
Radiated emissions	15.109	X				Mrs. E. Pitt, test engineer	July 9, 2002	
<b>General conditions under Part 15</b>								
The Intentional radiator operates in 905 - 924 MHz frequency range.	15.247	X						
The hopping sequence meets the requirement specified in the definition of a frequency hopping spread spectrum system	15.247, a(1)	X						For an example of a hopping sequence see Appendix D.
Each of the hopping channels is used equally on average	15.247 a(1)	X						
The associated receiver complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal	15.247 a(1)	X						
The EUT is designed to be capable of operating as a true frequency hopping system	15.247(g)	X						



Parameter	Subclause	C	NC	NT	NA	Tested by	Date tested	Remarks
The EUT does not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters	15.247(h)	X						
Examined frequencies:	15.31(m)							
Near the top	923.175 MHz							
Near the middle	916.3 MHz							
Near the bottom	905.6 MHz							
The intentional radiator has permanently attached antenna or antenna that uses a unique coupling to the intentional radiator.	15.203	X						
The intentional radiator has a standard connector and must be professionally installed. To demonstrate that professional installation is required, the following three points must be addressed: (a) the application (or intended use) of the EUT; (b) the installation requirements of the EUT, and (c) the method by which the EUT will be marketed.	15.203				X			
No antenna other than that furnished by the responsible party can be used with the device.	15.203	X						
Antenna technical characteristics, as referred to in "Transmitter description" table in the test report	15.204	X						
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, certification engineer

**Test report approved by:** Mr. A. Usoskin, QA manager



### 3 EUT description

#### 3.1 General description

The EUT, TMW 250FH, 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 250FH consists of two parts: spread spectrum frequency hopping transceiver with integral antenna and a microcontroller.

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

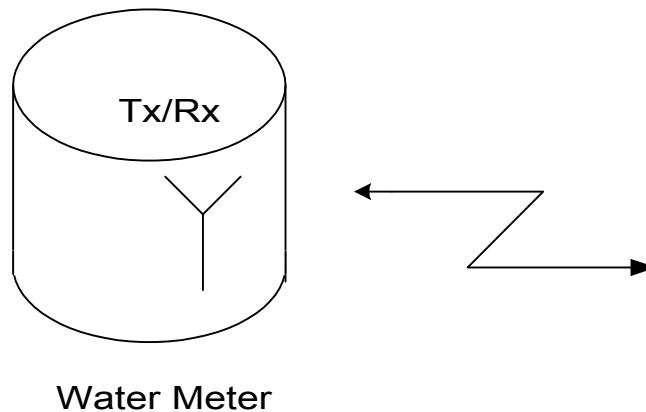
#### 3.2 EUT test configuration

The EUT test configuration is shown in Figure 3.2.1, clock and oscillator frequencies are provided in Table 3.2.1.

Table 3.2.1 EUT operating frequencies

Frequency	Card Id					
852.3 MHz	LO1					
53.3 MHz	LO2					
26.6353 MHz	clock1					
32.768 kHz	clock2					

Figure 3.2.1





### 3.3 Transmitter description

<b>Type of equipment</b>						
<input checked="" type="checkbox"/>	Stand-alone (Equipment with or without its own control provisions)					
<input type="checkbox"/>	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)					
<input type="checkbox"/>	Plug-in card (Equipment intended for a variety of host systems)					
<input type="checkbox"/>	Other:					
<b>Operating frequency range</b>		905 - 924 MHz				
<b>Spread spectrum technique used</b>						
<input checked="" type="checkbox"/>	Frequency hopping (FHSS)					
<input type="checkbox"/>	Direct sequence (DSSS)					
<input type="checkbox"/>	Combined					
<b>Spread spectrum parameters*</b>						
<b>DSSS</b>	chip sequence length (bits)					
	spectrum width (MHz)					
<b>FHSS</b>	total number of hops (units)	26				
	dwel time (milliseconds)	3.5				
	bandwidth per hop (MHz)	0.475				
	max. separation of hops (MHz)	0.8				
<b>Transmitter aggregate data rate</b> (bits per second)			60 kbit/s			
<b>Normal test signal</b>			transmit protocol, FSK			
<b>Maximum rated output power</b>						
At transmitter permanent external 50 Ω rf output connector (dBm)						
Effective radiated power (for equipment with integral antenna) (dBm)			18			
Is transmitter output power variable?	<input checked="" type="checkbox"/>	No				
	<input type="checkbox"/>	Yes	continuous variable			
	<input type="checkbox"/>		stepped variable			
	<input type="checkbox"/>		stepsize (dB):.....			
	<input type="checkbox"/>		minimum RF power (dBm):.....			
<input type="checkbox"/>		maximum RF power (dBm):.....				
<b>Transmitter power source</b>						
<input checked="" type="checkbox"/>	<b>Battery</b>	<b>Nominal rated voltage (VDC)</b>	3.6			
<input type="checkbox"/>	Nickel Cadmium					
<input type="checkbox"/>	Lithium					
<input type="checkbox"/>	Other					
<input type="checkbox"/>	<b>DC</b>	<b>Nominal rated voltage (VDC)</b>				
<input type="checkbox"/>	<b>AC mains</b>	<b>Nominal rated voltage (VAC)</b>				
Is there common power source for transmitter and receiver			<input checked="" type="checkbox"/> yes <input type="checkbox"/> no			
<b>Antenna technical characteristics</b>						
Integral	<input type="checkbox"/>	with temporary RF connector	<b>Type</b> PIFA	<b>Manufacturer</b> Telematics	<b>Model number</b> NA	<b>Gain</b> 2.5 dBi
	<input checked="" type="checkbox"/>	without temporary RF connector				
External						
<b>External antenna connection - NA</b>						
<input type="checkbox"/>	standard connector			<input type="checkbox"/>	unique coupling	

\* If more than 1 variant of any spectrum parameter may be used, provide all variations of these parameters.





## 4 Test results

### 4.1 Occupied bandwidth of hopping channels and channel carrier frequencies separation according to § 15.247(a)(1)

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.7
DATE:	July 9, 2002
RELATIVE HUMIDITY:	42 %
AMBIENT TEMPERATURE:	24 °C
OPERATING FREQUENCY RANGE	905-924 MHz
MODULATION TECHNIQUE	FHSS
HOPPING FUNCTION	Enabled

Carrier frequency, MHz	Measured 20 dB bandwidth, kHz	Reference to Plot in Appendix A
905.6	310	A1
916.3	375	A2
923.175	475	A3
Measurement uncertainty, ppm	± 0.21	

Frequency range	Channel carrier frequency separation	Reference to Plot in Appendix A
905 – 924	530 kHz	A4
Measurement uncertainty, dB		

#### TEST EQUIPMENT USED:

HL 0038	HL 0569	HL 0590	HL 0812	HL 1430	HL 1552	HL 1871
---------	---------	---------	---------	---------	---------	---------

#### LIMIT

Operating frequency range, MHz	Allowed bandwidth	Channel carrier frequency separation (minimum)
902-928	≤ 500 kHz @ 20 dBc	25 kHz or 20 dB bandwidth, which is greater
2400-2483.5; 5275-5850	≤ 1 MHz @ 20 dBc	
2400-2483.5	> 1 MHz @ 20 dBc	

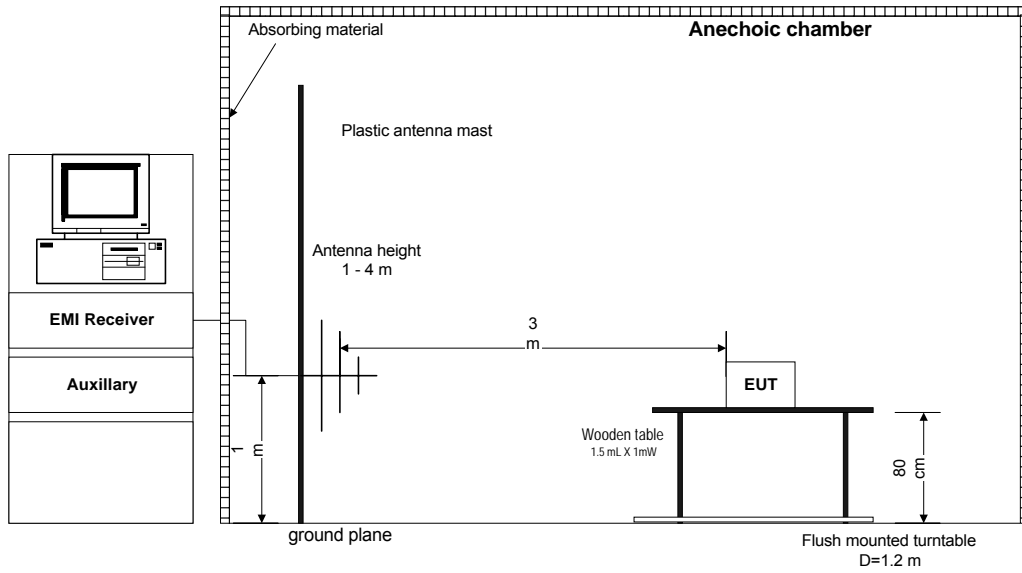
#### TEST PROCEDURE

The EUT was set up as shown in Figure 4.1.1. The measuring antenna was connected to spectrum analyzer, which settings are shown in Plots.

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.



Figure 4.1.1





## 4.2 Number of hopping channels according to § 15.247(a)(1)

METHOD OF MEASUREMENT                   ANSI 63.4 §13.1.7  
DATE:   July 9, 2002  
RELATIVE HUMIDITY:                             42 %  
AMBIENT TEMPERATURE:                       24 °C  
OPERATING FREQUENCY RANGE                 905-924 MHz  
MODULATION TECHNIQUE                       FHSS  
HOPPING FUNCTION                              Enabled

Occupied frequency range	Measured 20 dB BW, kHz	Number of channels	Reference to Plot in Appendix A
905-924	310	26	A4
Measurement uncertainty, dB			NA

### TEST EQUIPMENT USED:

HL 0038	HL 0569	HL 0590	HL 0812	HL 1430	HL 1552	HL 1871
---------	---------	---------	---------	---------	---------	---------

### LIMIT

Operating frequency range, MHz	20 dB bandwidth	Number of frequencies
902-928	< 250 kHz	≥ 50
	≥ 250 kHz	≥ 25
2400-2483.5; 5275-5850	≤ 1 MHz	≥ 75
2400-2483.5	> 1 MHz	≥ 15 non-overlapping channels with total span ≥ 75 MHz

### TEST PROCEDURE

The setup was the same as in Paragraph 4.1. The measuring antenna was connected to spectrum analyzer, which settings are shown in Plots.

**4.3 Average time of hopping frequency occupancy according to § 15.247(a)(1), (f)**

METHOD OF MEASUREMENT	ANSI 63.4 §13.1.7
DATE:	July 9, 2002
RELATIVE HUMIDITY:	42 %
AMBIENT TEMPERATURE:	24°C
OPERATING FREQUENCY RANGE	905-924 MHz
MODULATION TECHNIQUE	FHSS
HOPPING FUNCTION	Enabled

Carrier frequency, MHz	Time period between two successive transmissions	Tx ON	Average time of occupancy	Reference to Plot in Appendix A
916.3	6 s	3.53 ms	≤7.06 ms	A5, A6
Measurement uncertainty, ppm		± 0.21		

**TEST EQUIPMENT USED:**

HL 0038	HL 0569	HL 0590	HL 0812	HL 1430	HL 1552	HL 1871
---------	---------	---------	---------	---------	---------	---------

**4.3.1 Average factor calculation, §15.35**

According to TMW-250FH specifications, the maximal length of transmit protocol (including extended data packet) is 364 bit (@ 60 kbit/s), hence the maximal Tx ON is  $364/60000 = 6$  ms

Tx ON	Duty cycle	Average factor
6 ms	0.06	-24.4
Measurement uncertainty (1% of sweep time)		0.15 ms

**LIMIT**

Operating frequency range, MHz	Number of frequencies	Average time of occupancy
902-928	≥ 50	≤ 0.4 s within 20 s period
	≥ 25	≤ 0.4 s within 10 s period
2400-2483.5; 5275-5850	≥ 75	≤ 0.4 s within 30 s period
2400-2483.5	≥ 15 non-overlapping channels with total span ≥ 75 MHz	≤ 0.4 s within the time required to hop through all channels

**TEST PROCEDURE**

The setup was the same as in Paragraph 4.1. The measuring antenna was connected to spectrum analyzer, which settings are shown in Plots.



#### 4.4 Maximum peak output power test according to §15.247 (b)(1), (b)(2), (b)(3)

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.4
DATE:	July 9, 2002
RELATIVE HUMIDITY:	42 %
AMBIENT TEMPERATURE:	24 °C
OPERATING FREQUENCY RANGE	905-924 MHz
MODULATION TECHNIQUE	FHSS
HOPPING FUNCTION	Enabled

Carrier frequency, MHz	Peak output power, dBm	Limit, dBm	Margin, dB	Reference to Plots in Appendix A
905.6	14.79	24	9.21	A7
916.3	15.09	24	8.91	A8
923.175	15.16	24	8.84	A9
Measurement uncertainty, dB		+0.36/-0.38 dB		

#### TEST EQUIPMENT USED:

HL 0038	HL 0569	HL 0590	HL 0661	HL 0812	HL 1430	HL 1552
HL 1565	HL 1871	HL 1939				

#### LIMIT

Operating frequency range, MHz	Number of hopping channels	Maximum peak output power*, W
902-928 (hopping)	≥ 50	1
	< 50	0.25
2400-2483.5 (hopping)	≥ 75	1
	other admissible	0.125
5275-5850 (hopping)	any admissible	1
902-928; 2400-2483.5; 5275-5850 (direct sequence)	NA	1

#### \* Notes to table

1. If transmitting antennas of directional gain greater than 6 dB are used, the peak output power shall be reduced below the stated values by the amount in dB that the directional gain of the antenna exceeds 6 dBi with the following exceptions:

- Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi;
- Systems operating in the 5275-5850 MHz band, that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power;
- Fixed, point-to-point operation as used in paragraphs a) and b) of Notes, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information.

For more details see 15.247 (b)(3).

#### TEST PROCEDURE

Field strength of carrier was measured at 3 m test distance.

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.

The peak output power was calculated as referred to in pages 23 to 25.



#### 4.5 Exposure limit according to §15.247(b)(4) and §1.1310

Limit for power density for general population/uncontrolled exposure is  $P = 0.6 \text{ mW/cm}^2$

The power density  $P \text{ (mW/cm}^2\text{)} = PT / 4\pi r^2$ , where

PT - the transmitted power, which is equal to the transmitter output plus antenna gain.

PT = 15.16 + 2.5 = 17.66 dBm = 58 mW

The minimum safe distance "r", where RF exposure does not exceed FCC permissible limit, is 2.8 cm.

$$r = \sqrt{PT / (Px4\pi)} = \sqrt{58 / (0.6 \times 12.56)} = 2.8$$

Conclusion: The public cannot be exposed to dangerous RF level.



#### 4.6 Out of band radiated emissions test according to §15.247(c)

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.4
DATE:	July 9, 2002
RELATIVE HUMIDITY:	42 %
AMBIENT TEMPERATURE:	24 °C
RATED RF OUTPUT POWER	18 dBm
TEST DISTANCE	3 m
OPERATING FREQUENCY RANGE	905-924 MHz
MODULATION TECHNIQUE	FHSS
HOPPING FUNCTION	Enabled
FREQUENCY RANGE*	9 kHz – 9.5 GHz

\*The frequency spectrum was investigated from 9 kHz up to the tenth harmonic of the highest fundamental frequency.

**No spurious emissions except 3<sup>rd</sup> harmonic were found. For test results refer to Appendix A, Plots A10 to A22.**

#### TEST EQUIPMENT USED:

HL 0041	HL 0446	HL 0465	HL 0521	HL 0554	HL 0589	HL 0590
HL 0604	HL 1004	HL 1200	HL 1424	HL 1871	HL 1942	

#### 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

**9 kHz – 30 MHz frequency range.** The EUT was placed on a wooden 80 cm height turntable. The loop antenna was positioned with its plane vertical. The loop center was 1 meter above the ground plane. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated about its vertical axis.

**30 MHz – 9.5 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.



#### 4.7 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/ §13.1.5
DATE:	July 9, 2002
RELATIVE HUMIDITY:	42 %
AMBIENT TEMPERATURE:	24 °C
RATED RF OUTPUT POWER	18 dBm
TEST DISTANCE	3 m
OPERATING FREQUENCY RANGE	905-924 MHz
MODULATION TECHNIQUE	FHSS
HOPPING FUNCTION	Enabled
FREQUENCY RANGE*	9 kHz – 9.5 GHz

\*The frequency spectrum was investigated from 9 kHz up to the tenth harmonic of the highest fundamental frequency.

Peak detector, RBW = VBW = 1 MHz

Frequency, MHz	Antenna type	Antenna polarization	Radiated emission, dB (µV/m)	Limit, dB(µV/m)	Margin, dB	Reference to Plots in Appendix A
2748	Horn	Vertical	56.8	74	17.2	A17
Measurement uncertainty, dB			± 2.36 dB			

Peak detector + average factor (refer to paragraph 4.3.1)

Frequency, MHz	Antenna type	Antenna polarization	Radiated emission, dB (µV/m)	Limit, dB(µV/m)	Margin, dB	Reference to Plots in Appendix A
2748	Horn	Vertical	32.4	54	21.6	NA
Measurement uncertainty, dB			± 2.36 dB			

**Notes to table:**

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

RBW = resolution bandwidth;

VBW = video bandwidth.

**TEST EQUIPMENT USED:**

HL 0041	HL 0446	HL 0465	HL 0521	HL 0554	HL 0589	HL 0590
HL 0604	HL 1004	HL 1200	HL 1424	HL 1871	HL 1942	

**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 EUT was placed on a wooden 80 cm height turntable. The loop antenna was positioned with its plane vertical. The loop center was 1 meter above the ground plane. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated about its vertical axis.

**30 MHz – 9.5 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.





## 4.8 Unintentional radiated emissions test according to §15.109

METHOD OF MEASUREMENT: ANSI 63.4 §11.6 / ANSI 63.4 §12.1.4  
TEST PERFORMED IN: ANECHOIC CHAMBER  
DATE: July 9, 2002  
RELATIVE HUMIDITY: 42 %  
AMBIENT TEMPERATURE: 24 °C  
DISTANCE BETWEEN ANTENNA AND EUT: 3 m  
THE EUT WAS TESTED AS: TABLE-TOP  
FREQUENCY RANGE: 30 MHz – 5 GHz  
DETECTOR TYPE: QUASI-PEAK  
RESOLUTION BANDWIDTH: 120 kHz  
OPERATING MODE: RECEIVING

	The EUT highest used frequency (not including operating frequency), MHz	Upper frequency of measurement range, MHz
	Below 1.705	30
	1.705 – 108	1000
	108 – 500	2000
<b>X</b>	500 – 1000	5000
	Above 1000	5 <sup>th</sup> harmonic of the highest frequency or 40 GHz, whichever is lower

Frequency, MHz	Antenna polarization	Antenna height, m	Turntable position (°)	Radiated emissions, dB (µV/m)	Limit, dB (µV/m)	Margin, dB	Reference to Plots in Appendix A
952.3	Vertical	1.0	16	35.5	46	10.5	A23 to A25
Measurement uncertainty, dB				+5.42 dB/-5.26 dB			

### Table abbreviations:

Antenna polarization: V = vertical, H = horizontal

Turntable position: 0° = EUT front panel faces the receiving antenna

### TEST EQUIPMENT USED:

HL 0041	HL 0465	HL 0521	HL 0589	HL 1004	HL 1947	
---------	---------	---------	---------	---------	---------	--

### LIMIT (§ 15.109)

Frequency, MHz	Class A equipment @ 10 m dB(µV/m)	Class B equipment @ 3 m dB(µV/m)
30 - 88	39.0	40
88 - 216	43.5	43.5
216 - 960	46.4	46
960 - 5000	49.5	54

### TEST PROCEDURE

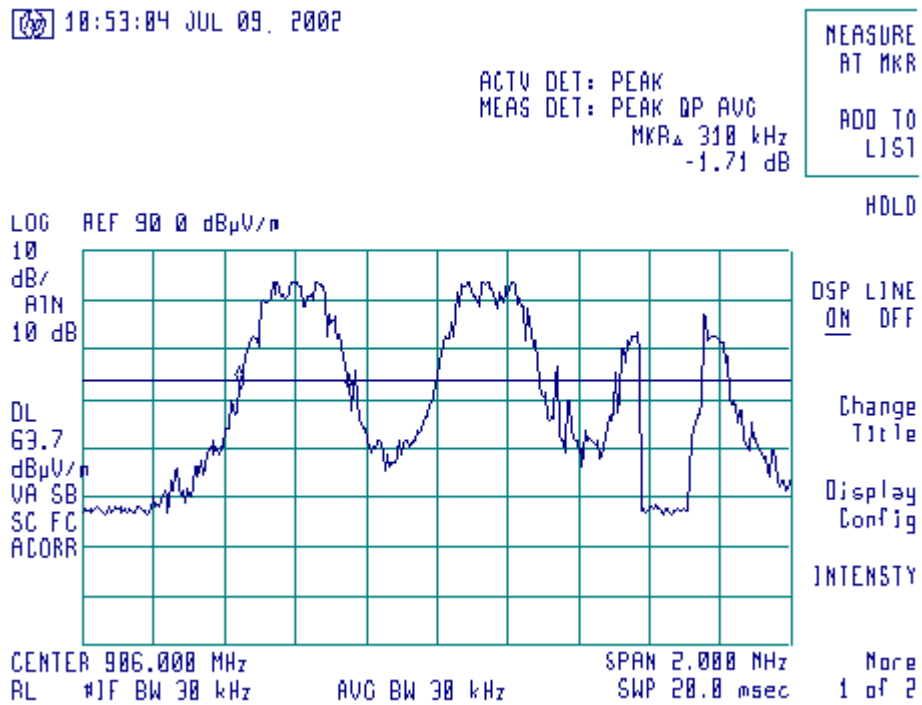
The EUT was placed on a wooden 80 cm height turntable. To find maximum radiation the turntable was rotated 360°, measuring antenna height was changed from 1 to 4 m, and the antennas polarization was changed from vertical to horizontal.



## Appendix A Plots

Plot A 1

20 dB bandwidth for hopping system



**Notes**  
External attenuation 20 dB  
Fmin = 905.59 MHz



Plot A 2

20 dB bandwidth for hopping system

11:11:27 JUL 09, 2002

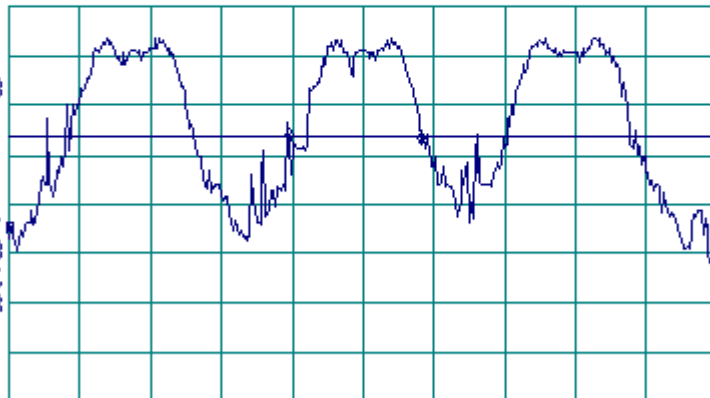
ACTV DET: PEAK  
MEAS DET: PEAK DP AVG  
MKR  $\Delta$  375 kHz  
-.61 dB

MEASURE  
AT MKR  
ADD TO  
LIST

LOG REF 90 0 dB $\mu$ V/m

10  
dB/  
RTN  
10 dB

DL  
63.7  
dB $\mu$ V/  
MA SB  
SC FC  
ACORR



MARKER  
NORMAL

MARKER  
 $\Delta$

MARKER  
AMPTD

SELECT  
1 2 3 4

MARKER 1  
DN OFF

CENTER 916.300 MHz  
RL #1F BW 30 kHz

AVG BW 30 kHz

SPAN 2.000 MHz  
SWP 20.0 msec

More  
1 of 2

Notes

External attenuation 20 dB

Fmiddle = 916.3 MHz



Plot A 3

20 dB bandwidth for hopping system

11:38:51 JUL 09, 2002

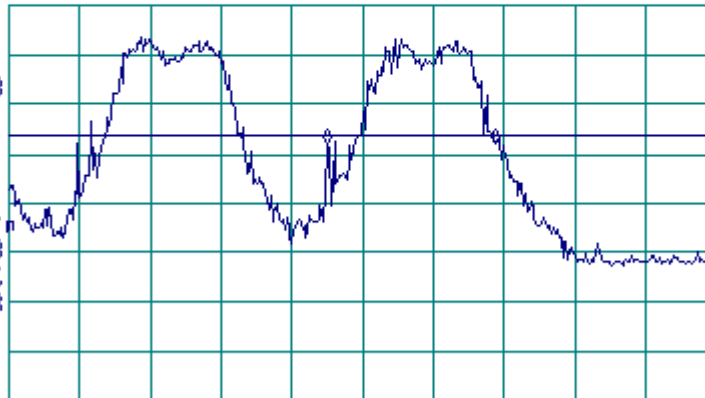
ACTV DET: PEAK  
MEAS DET: PEAK OP AVG  
MKR $\Delta$  475 kHz  
-.13 dB

MEASURE  
AT MKR  
ADD TO  
LIST

LOG REF 90 0 dB $\mu$ V/m

10  
dB/  
RTN  
10 dB

DL  
63.6  
dB $\mu$ V/m  
VA SB  
SC FC  
ACORR



CLEAR  
WRITE A

MAX  
HOLD A

VIEW A

BLANK A

Trace  
A B C

More  
1 of 3

Notes

External attenuation 20 dB  
Fhigh = 923.175 MHz



Plot A 4

Frequency separation

10:48:35 JUL 09, 2002

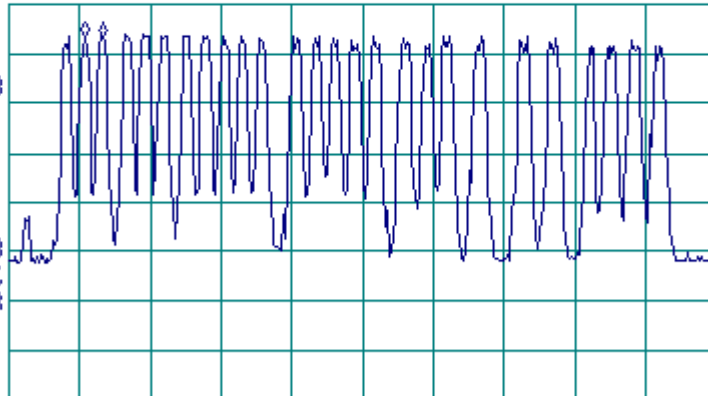
ACTV DET: PEAK  
MEAS DET: PEAK OP AVG  
MKRΔ 530 kHz  
-.58 dB

MEASURE  
AT MKR  
ADD TO  
LIST

LOG REF 90 0 dBμV/m

10  
dB/  
ATN  
10 dB

VA SB  
SC FC  
ACORR



START 984.00 MHz STOP 925.00 MHz  
R 1JF BW 30 kHz AVG BW 30 kHz SWP 70.0 msec

CLEAR  
WRITE A  
MAX  
HOLD A

VIEW A

BLANK A

Trace  
A B C

More  
1 of 3

Notes

External attenuation 20 dB  
Total number of hops = 26



Plot A 5

Average time of hopping frequency occupancy

11:49:56 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR  $\Delta$  3.5250 msec  
.72 dB

MEASURE  
AT MKR  
ADD TO  
LIST

LOG REF 90 0 dB $\mu$ V/n

10  
dB/  
ATN  
10 dB

VA SB  
SC FC  
ACORR

CENTER 916.300 MHz SPAN 0 Hz  
RL #JF BW 300 kHz AVG BW 100 kHz #SWP 15.0 msec

MARKER  
NORMAL

MARKER  
 $\Delta$

MARKER  
AMPTD

SELECT  
1 2 3 4

MARKER 1  
DN OFF

More  
1 of 2

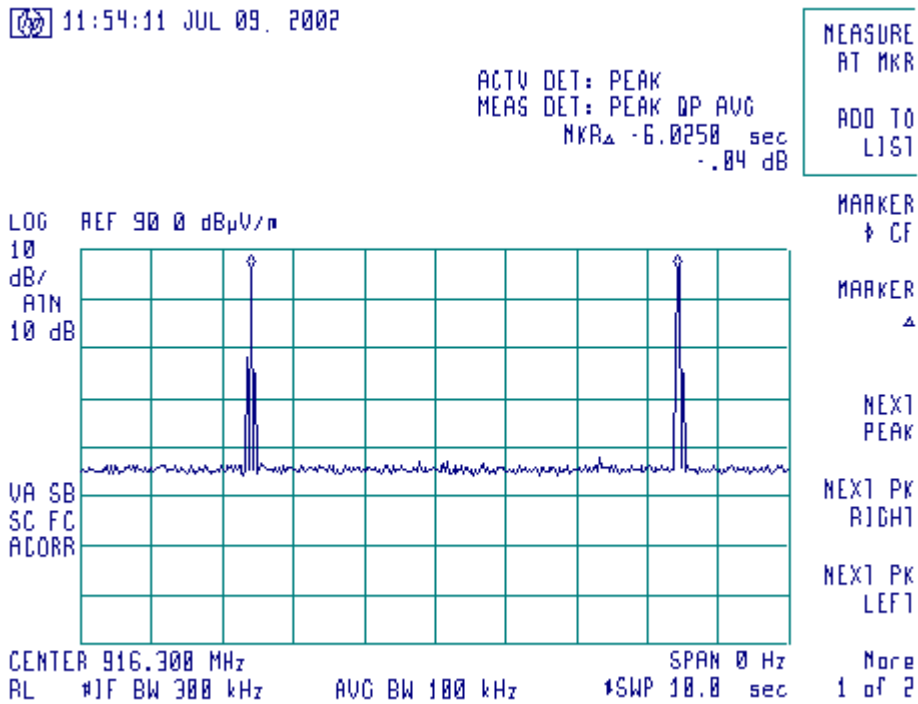
Notes

External attenuation 20 dB  
Fmiddle= 916.3 MHz



Plot A 6

Average time of hopping frequency occupancy



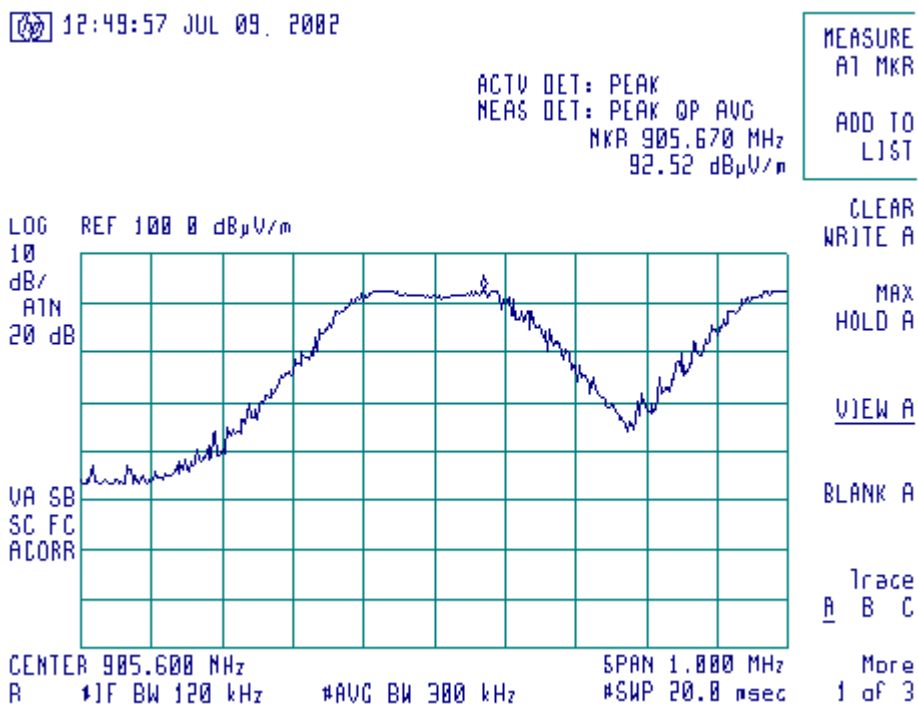
Notes

External attenuation 20 dB  
Fmiddle= 916.3 MHz



Plot A 7

Peak output power measurements



Notes

External attenuation: 20 dB

Fmin= 905.6 MHz

Antenna polarization: vertical

E = 92.52 + 20 = 112.52 dB(μV/m) @ 3 m

Calculation of peak output power: 112.52 – 95.23 – 2.5 (Antenna gain) = 14.79 dBm





Plot A 8

Peak output power measurements

12:35:48 JUL 09, 2002

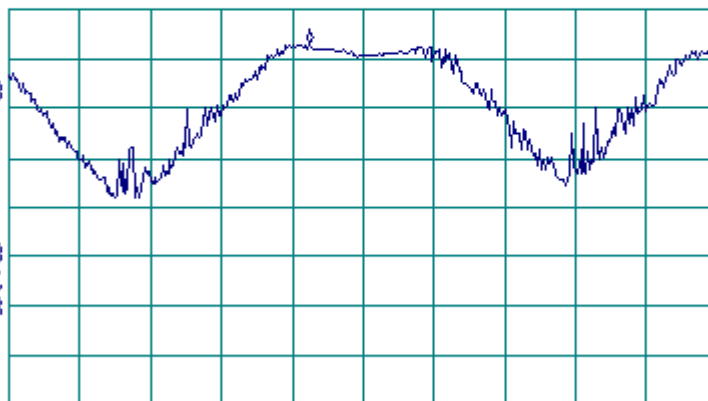
ACTV DET: PEAK  
MEAS DET: PEAK OP AVG  
MKR 916.225 MHz  
92.82 dB $\mu$ V/m

MEASURE  
AT MKR  
ADD TO  
LIST

LOG REF 100 0 dB $\mu$ V/m

10  
dB/  
RTN  
20 dB

VA SB  
SC FC  
ACORR



CENTER 916.300 MHz SPAN 1.000 MHz  
RL #1F BW 120 kHz #AVG BW 300 kHz #SWP 20.0 msec

MARKER  
↓ CF

MARKER  
▲

NEXT  
PEAK

NEXT PK  
RIGHT

NEXT PK  
LEFT

More  
1 of 2

Notes

External attenuation 20 dB

Fmiddle= 916.3 MHz

Antenna polarization: vertical

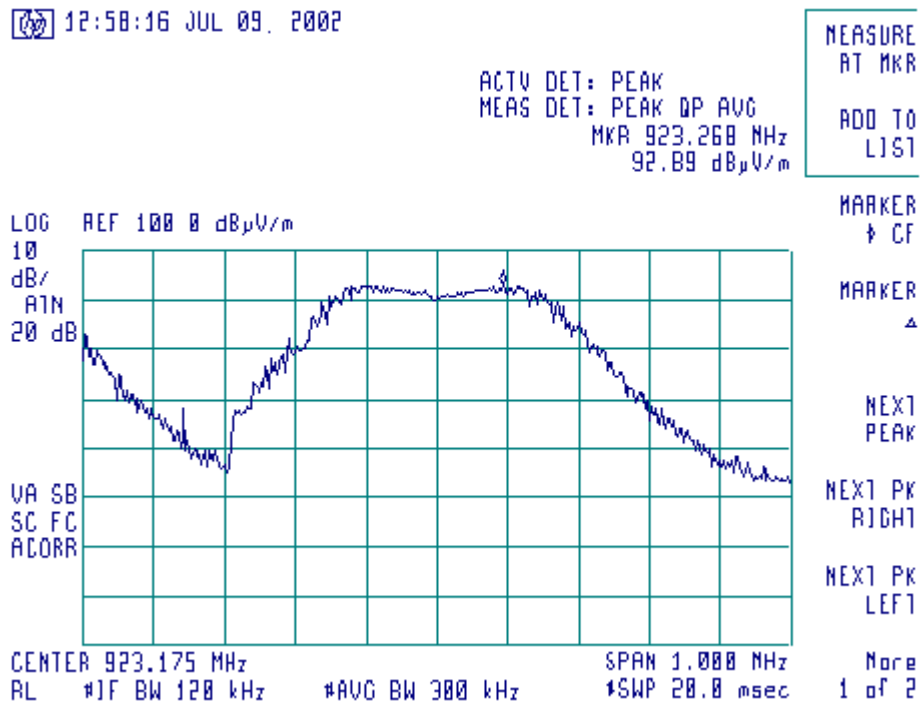
E = 92.82 + 20 = 112.82 dB( $\mu$ V/m) @ 3 m

Calculation of peak output power: 112.82 – 95.23 – 2.5 (Antenna gain) = 15.09 dBm



Plot A 9

Peak output power measurements



Notes

External attenuation: 20 dB

Fhigh= 923.175 MHz

Antenna polarization: vertical

E = 92.89 + 20 = 112.89 dB( $\mu$ V/m) @ 3 m

Calculation of peak output power: 112.89 – 95.23 – 2.5 (Antenna gain) = 15.16 dBm



Plot A 10

Spurious emission measurements  
9 kHz – 150 kHz frequency range

15:42:31 MAR 10, 2002

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 9.0 kHz  
62.02 dB $\mu$ V/m

MEASURE  
AT MKR

ADD TO  
LIST

MARKER  
↕ CF

MARKER  
▲

NEXT  
PEAK

NEXT PK  
RIGHT

NEXT PK  
LEFT

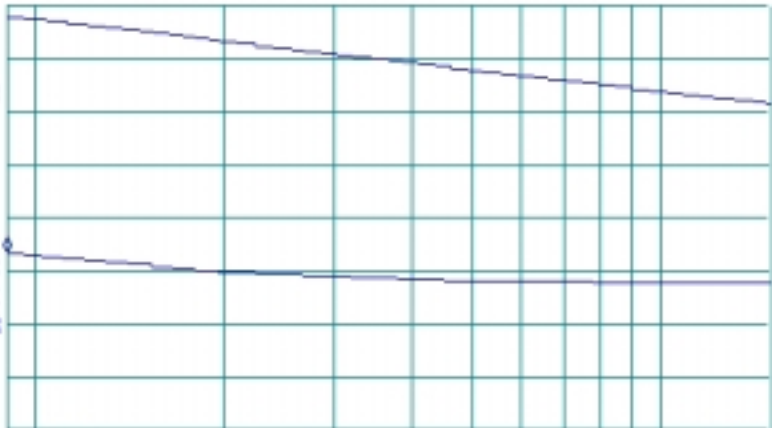
More  
1 of 2

LOG REF 132.0 dB $\mu$ V/m

15  
dB/  
ATN  
50 dB

VA SB  
SC FC  
ACORR

START 9.0 kHz STOP 150.0 kHz  
RL #1F BW 200 Hz #AVG BW 30 kHz SWP 10.3 sec



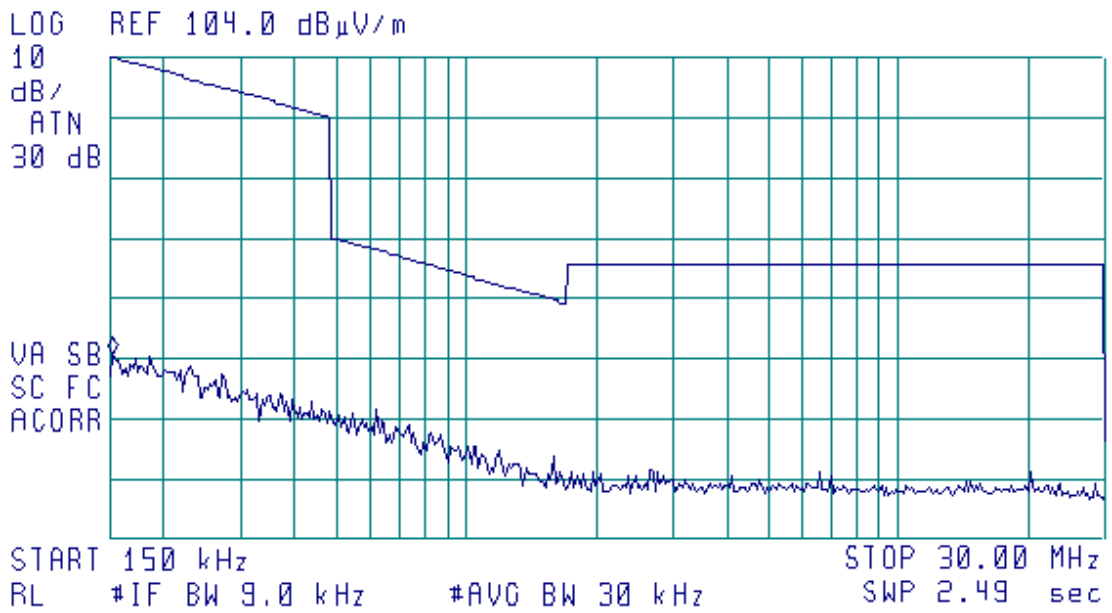


Plot A 11

Spurious emission measurements  
150 kHz – 30 MHz frequency range

15:46:54 MAR 18, 2002

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 150 kHz  
54.60 dB $\mu$ V/m





Plot A 12

Spurious emission measurements  
30 MHz – 900 MHz frequency range

14:43:44 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK OP AVG  
MKR 867.4 MHz  
59.44 dB $\mu$ V/m

MEASURE  
AT MKR

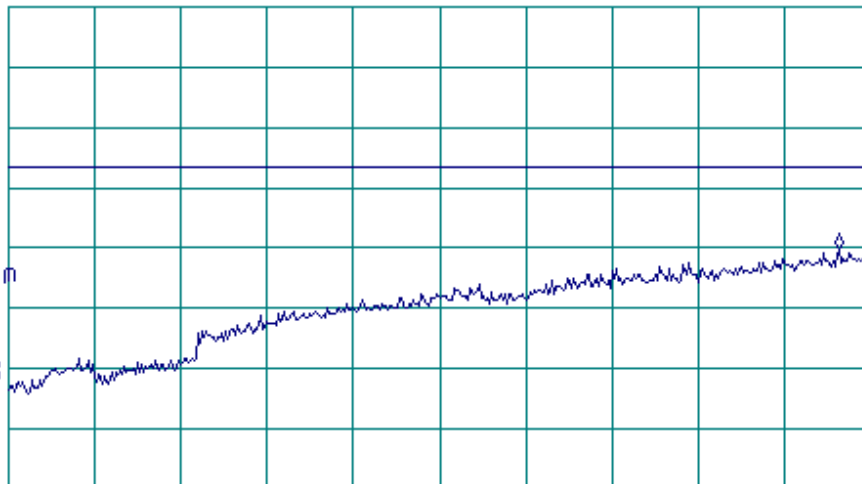
ADD TO  
LIST

LOG REF 100.0 dB $\mu$ V/m

PREAMP ON

10  
dB/  
ATN  
30 dB

DL  
73.3  
dB $\mu$ V/m  
VA SB  
SC FC  
ACORR



START 30.0 MHz

STOP 900.0 MHz

R #1F BW 100 kHz #AVC BW 300 kHz

SWP 261 msec

MARKER  
↓ CF

MARKER  
△

NEXT  
PEAK

NEXT PK  
RIGHT

NEXT PK  
LEFT

More  
1 of 2

Notes

External attenuation: 20 dB



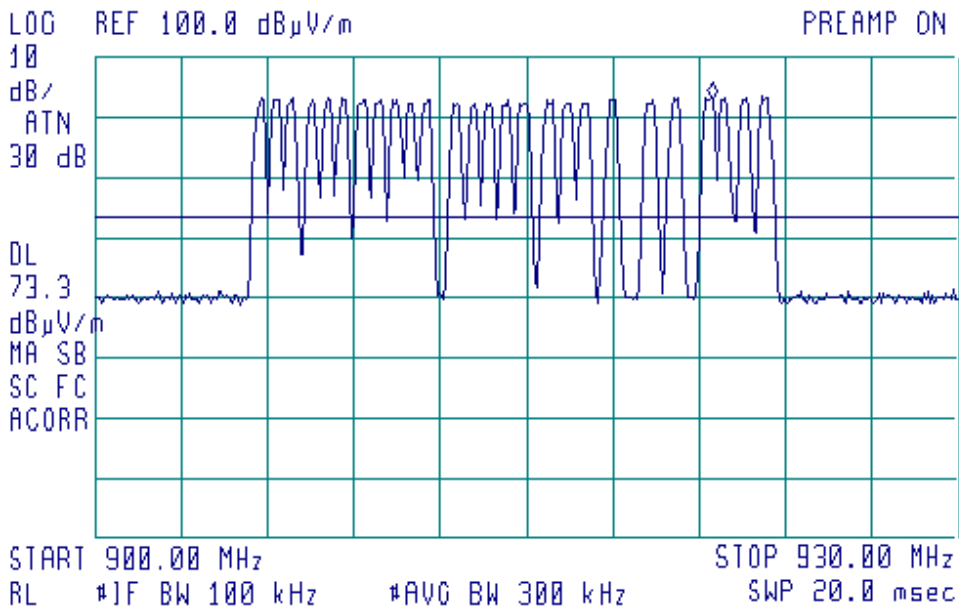
Plot A 13

Spurious emission measurements  
900 MHz – 930 MHz frequency range

14:40:34 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 921.45 MHz  
93.12 dB $\mu$ V/m

MEASURE  
AT MKR  
ADD TO  
LIST



MARKER  
+ CF  
MARKER  
 $\Delta$   
NEXT  
PEAK  
NEXT PK  
RIGHT  
NEXT PK  
LEFT  
More  
1 of 2

Notes  
External attenuation: 20 dB



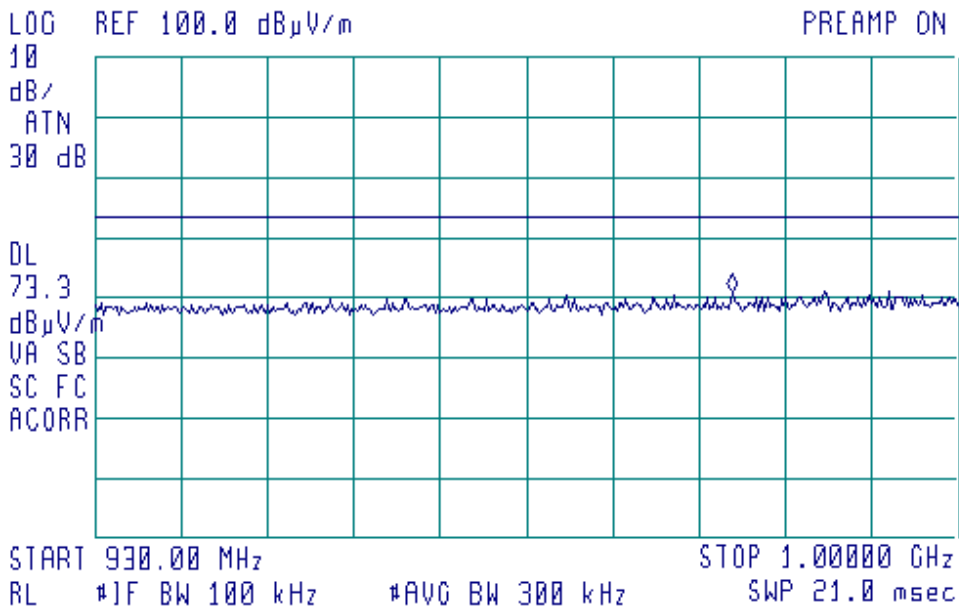
Plot A 14

Spurious emission measurements  
930 MHz – 1000 MHz frequency range

14:42:19 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 981.63 MHz  
60.76 dB $\mu$ V/m

MEASURE  
AT MKR  
ADD TO  
LIST



MARKER  
+ CF

MARKER  
 $\Delta$

NEXT  
PEAK

NEXT PK  
RIGHT

NEXT PK  
LEFT

More  
1 of 2

Notes  
External attenuation: 20 dB



Plot A 15

Spurious emission measurements  
1 GHz – 2 GHz frequency range

14:51:36 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 2.000 GHz  
49.15 dB $\mu$ V/m

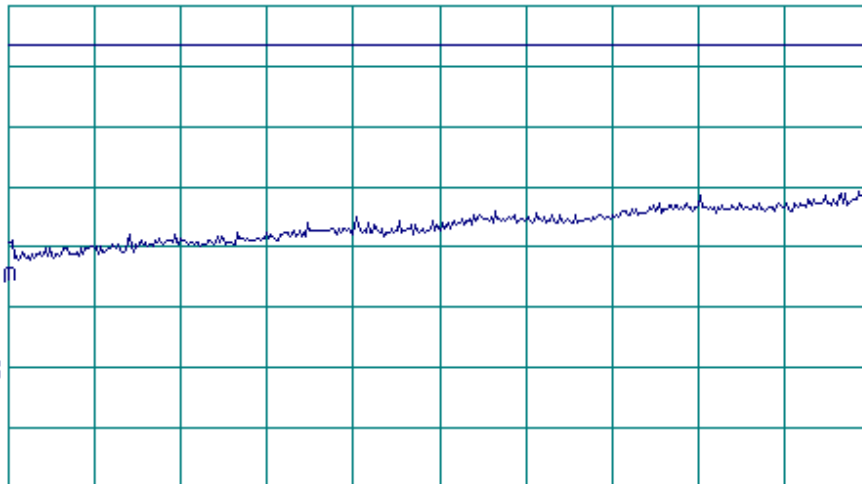
MEASURE  
AT MKR  
ADD TO  
LIST

LOG REF 80.0 dB $\mu$ V/m

PREAMP ON

10  
dB/  
ATN  
10 dB

DL  
73.3  
dB $\mu$ V/m  
VA SB  
SC FC  
ACORR



START 1.000 GHz

STOP 2.000 GHz

R #1F BW 100 kHz

#AVG BW 300 kHz

SWP 300 msec

MARKER  
↓ CF

MARKER  
▲

NEXT  
PEAK

NEXT PK  
RIGHT

NEXT PK  
LEFT

More  
1 of 2

Notes

External attenuation: 20 dB





Plot A 16

Spurious emission measurements  
2 GHz – 2.9214 GHz frequency range

15:45:49 JUL 09, 2002

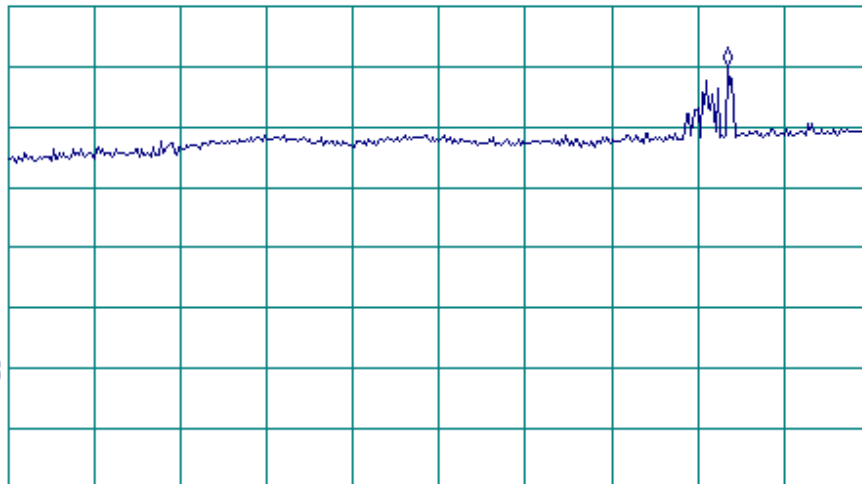
ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 2.7694 GHz  
50.23 dBμV/m

MEASURE  
AT MKR  
  
ADD TO  
LIST

LOG REF 60.0 dBμV/m

PREAMP ON

10  
dB/  
#ATN  
0 dB



CLEAR  
WRITE A

MAX  
HOLD A

VIEW A

BLANK A

Trace  
A B C

START 2.0000 GHz

STOP 2.9214 GHz

RL #1F BW 100 kHz

#AVG BW 300 kHz

SWP 276 msec

More  
1 of 3

Notes  
Without external attenuation



Plot A 17

Spurious emission measurements  
2.748 GHz - center frequency

15:33:52 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK OP AVG  
MKR 2.746863 GHz  
56.80 dBμV/m

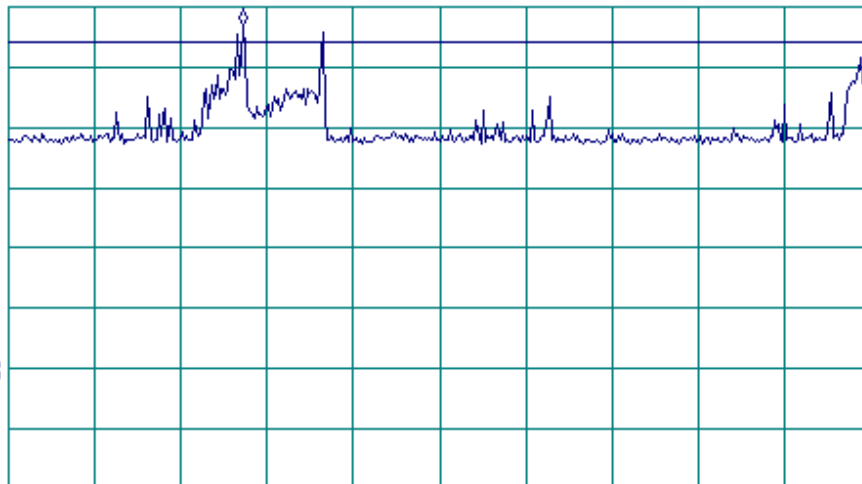
MEASURE  
AT MKR

ADD TO  
LIST

LOG REF 60.0 dBμV/m

PREAMP ON

10  
dB/  
#ATN  
0 dB



MARKER  
↓ CF

MARKER  
△

NEXT  
PEAK

NEXT PK  
RIGHT

NEXT PK  
LEFT

CENTER 2.748000 GHz

SPAN 5.000 MHz

RL #1F BW 100 kHz

#AVG BW 300 kHz

SWP 20.0 msec

More  
1 of 2

Notes  
Without external attenuation



Plot A 18

Spurious emission measurements  
2.9 GHz – 4 GHz frequency range

15:50:01 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK DP AVG  
MKR 3.623 GHz  
41.10 dB $\mu$ V/m

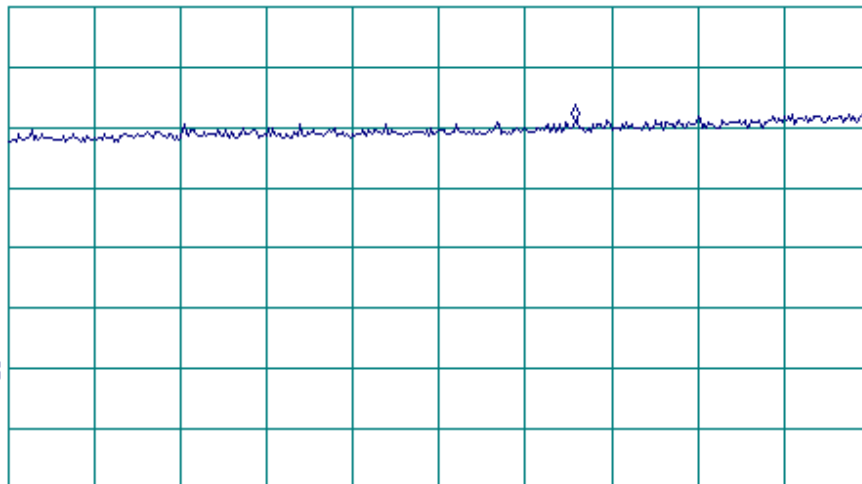
MEASURE  
AT MKR  
ADD TO  
LIST

LOG REF 60.0 dB $\mu$ V/m

PREAMP ON

CLEAR  
WRITE A

10  
dB/  
#ATN  
0 dB



MAX  
HOLD A

VIEW A

VA SB  
SC FC  
ACORR

BLANK A

Trace  
A B C

START 2.900 GHz

STOP 4.000 GHz

RL #1F BW 100 kHz

#AVC BW 300 kHz

SWP 330 msec

More  
1 of 3

Notes

Without external attenuation



Plot A 19

Spurious emission measurements  
3.6 GHz – center frequency

15:57:27 JUL 09, 2002

SPAN  
10.00 MHz

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 3.66000 GHz  
41.29 dB $\mu$ V/m

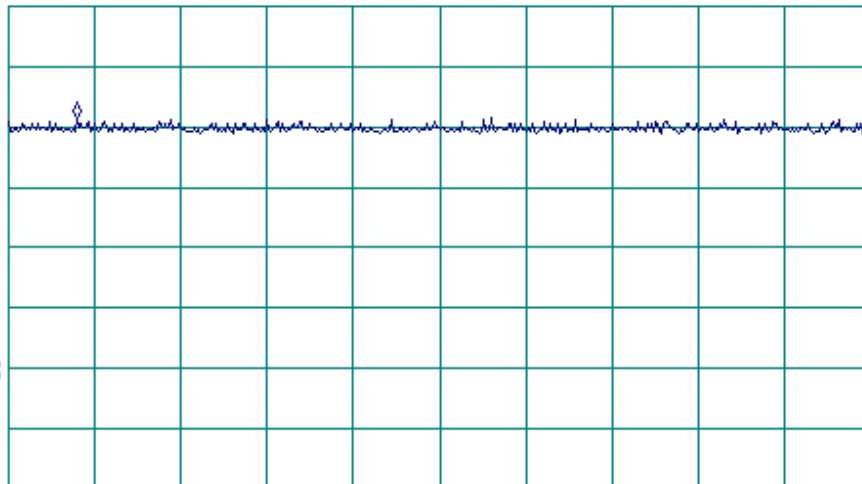
MEASURE  
AT MKR

ADD TO  
LIST

LOG REF 60.0 dB $\mu$ V/m

PREAMP ON

10  
dB/  
#ATN  
0 dB



MARKER  
↓ CF

MARKER  
▲

NEXT  
PEAK

NEXT PK  
RIGHT

NEXT PK  
LEFT

CENTER 3.66500 GHz

SPAN 10.00 MHz

RL #1F BW 100 kHz

#AVG BW 300 kHz

SWP 20.0 msec

More  
1 of 2

Notes  
Without external attenuation



Plot A 20

Spurious emission measurements  
4 GHz – 6.5 GHz frequency range

16:02:06 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK QP AVG  
MKR 6.250 GHz  
49.14 dBμV/m

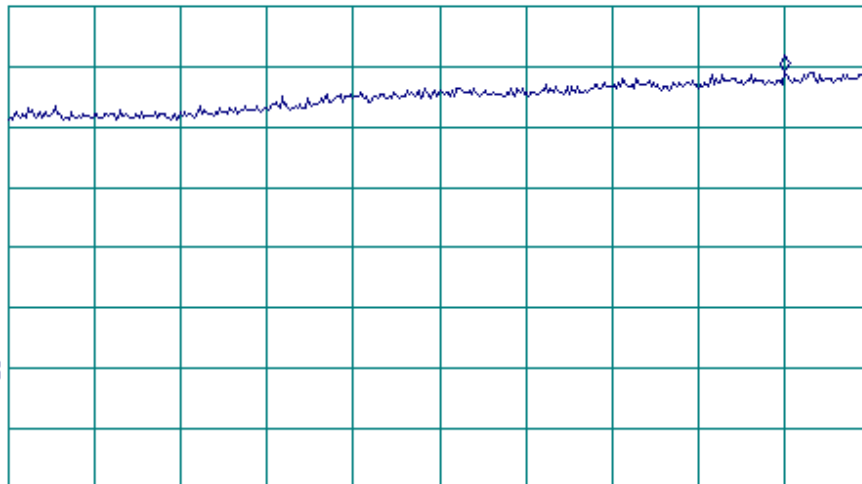
MEASURE  
AT MKR

ADD TO  
LIST

LOG REF 60.0 dBμV/m

PREAMP ON

10  
dB/  
#ATN  
0 dB



MARKER  
↓ CF

MARKER  
▲

NEXT  
PEAK

NEXT PK  
RIGHT

NEXT PK  
LEFT

START 4.000 GHz

STOP 6.500 GHz

RL #1F BW 100 kHz

#AVG BW 300 kHz

SWP 750 msec

More  
1 of 2

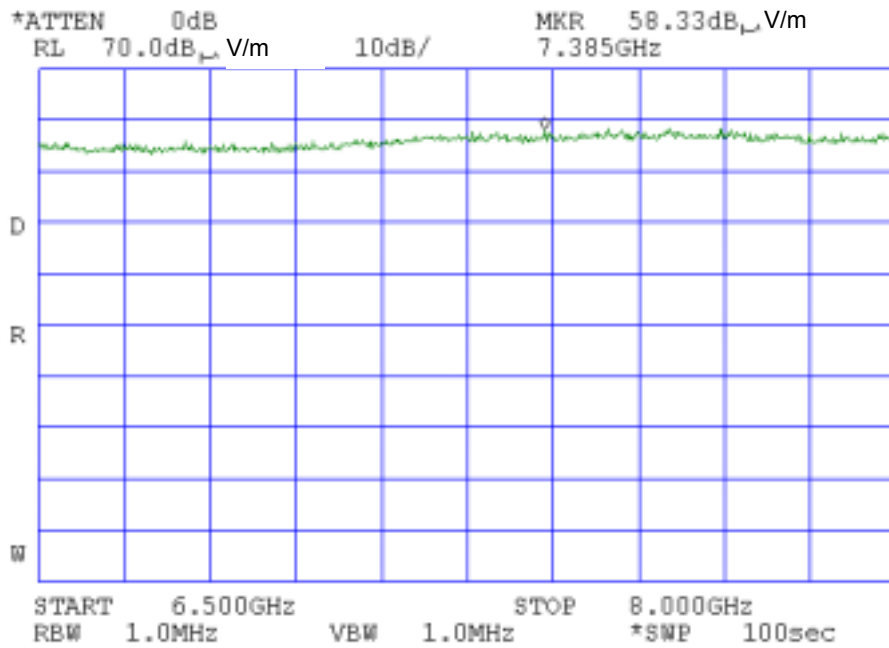
Notes

Without external attenuation



Plot A 21

Spurious emission measurements  
6.5 GHz – 8 GHz frequency range

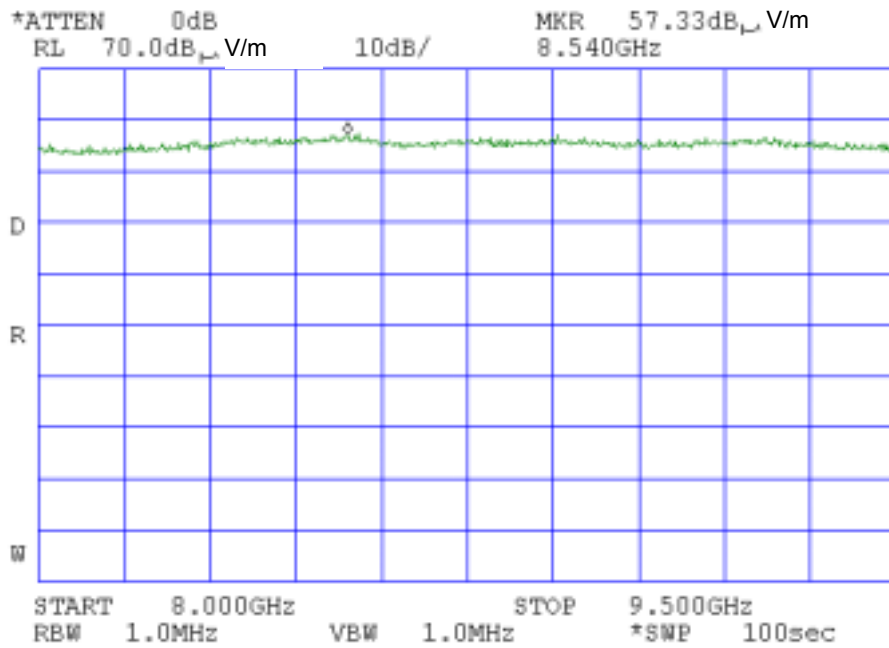


Notes  
Without external attenuation



Plot A 22

Spurious emission measurements  
8 GHz – 9.5 GHz frequency range



Notes  
Without external attenuation



Plot A 23

Unintentional radiation measurements  
30 MHz – 1000 MHz frequency range

14:12:24 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK OP AVG  
MKR 952.3 MHz  
35.49 dB $\mu$ V/m

MEASURE  
AT MKR

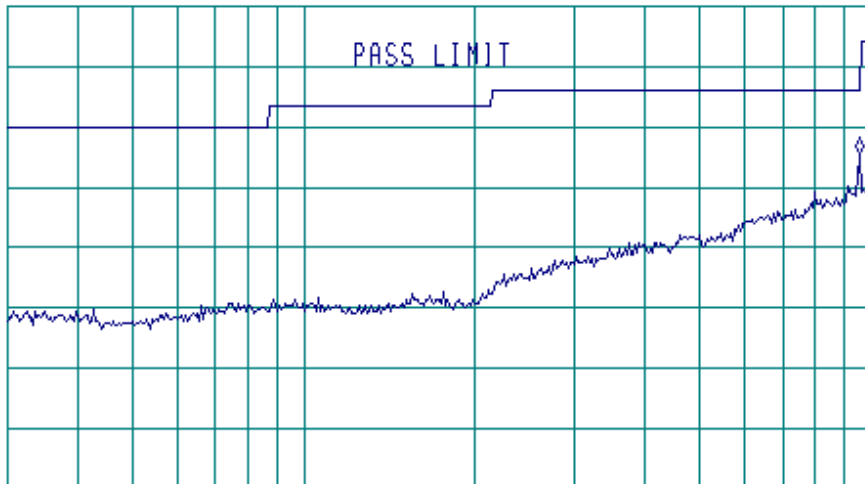
ADD TO  
LIST

LOG REF 60.0 dB $\mu$ V/m

PREAMP ON

10  
dB/  
#ATN  
0 dB

VA SB  
SC FC  
ACORR



MARKER  
↓ CF

MARKER  
▲

NEXT  
PEAK

NEXT PK  
RIGHT

NEXT PK  
LEFT

START 30.0 MHz

STOP 1.0000 GHz

RL #1F BW 120 kHz

AVG BW 300 kHz

SWP 909 msec

More  
1 of 2

Notes  
Mode: Rx  
Antenna. Polarization-Vertical & Horizontal





Plot A 24

Unintentional radiation measurements  
1000 MHz – 2000 MHz frequency range

14:21:47 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK OP AVG  
MKR 1.980 GHz  
46.09 dB $\mu$ V/m

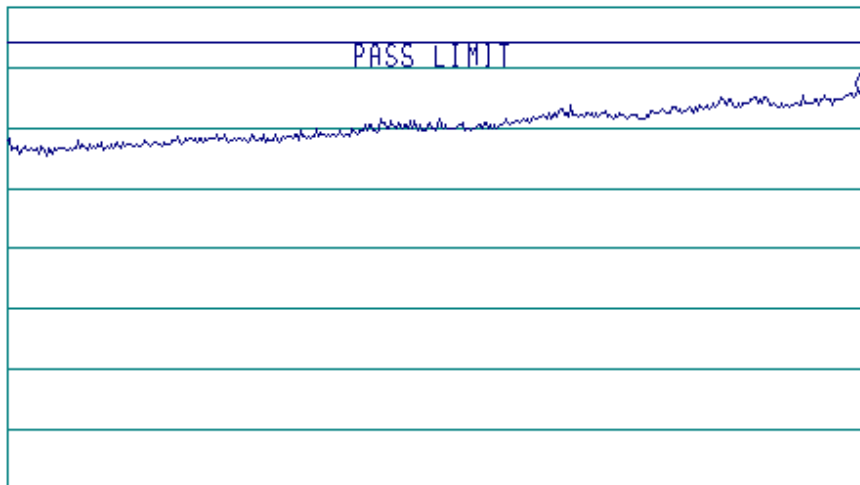
MEASURE  
AT MKR  
  
ADD TO  
LIST

LOG REF 60.0 dB $\mu$ V/m

PREAMP ON

MARKER  
↓ CF

10  
dB/  
#ATTN  
0 dB



MARKER  
▲

NEXT  
PEAK

NEXT PK  
RIGHT

NEXT PK  
LEFT

START 1.000 GHz

STOP 2.000 GHz

More

RL #1F BW 1.0 MHz

#AVG BW 1 MHz

SWP 700 msec

1 of 2

Notes

Mode: Rx

Antenna. Polarization-Vertical & Horizontal



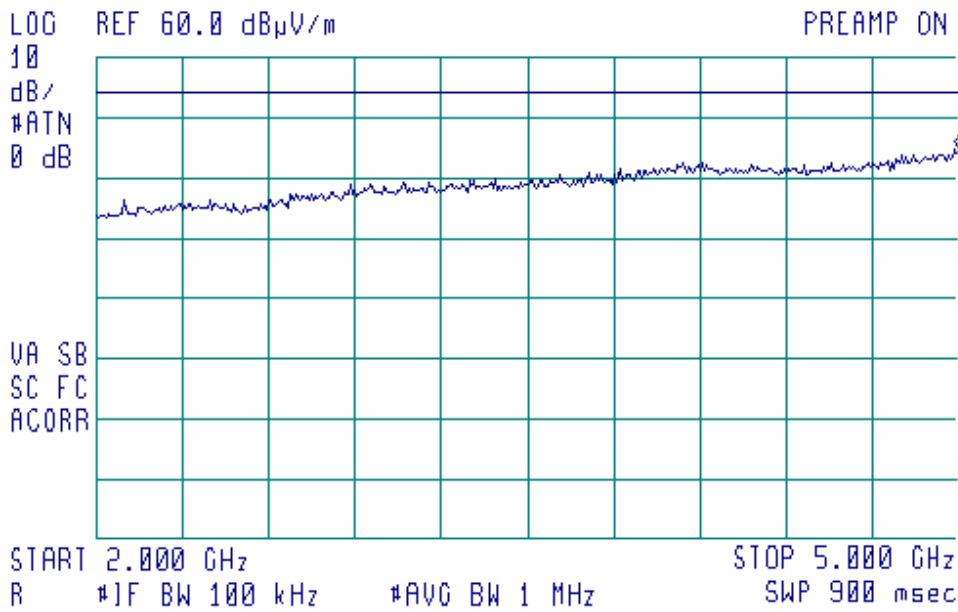
Plot A 25

Unintentional radiation measurements  
2000 MHz – 5000 MHz frequency range

16:18:52 JUL 09, 2002

ACTV DET: PEAK  
MEAS DET: PEAK OP AVG  
MKR 5.000 GHz  
44.63 dB $\mu$ V/m

MEASURE AT MKR  
ADD TO LIST  
MARKER  $\downarrow$  CF  
MARKER  $\Delta$   
NEXT PEAK  
NEXT PK RIGHT  
NEXT PK LEFT  
More 1 of 2



Notes  
Mode: Rx  
Antenna. Polarization-Vertical & Horizontal



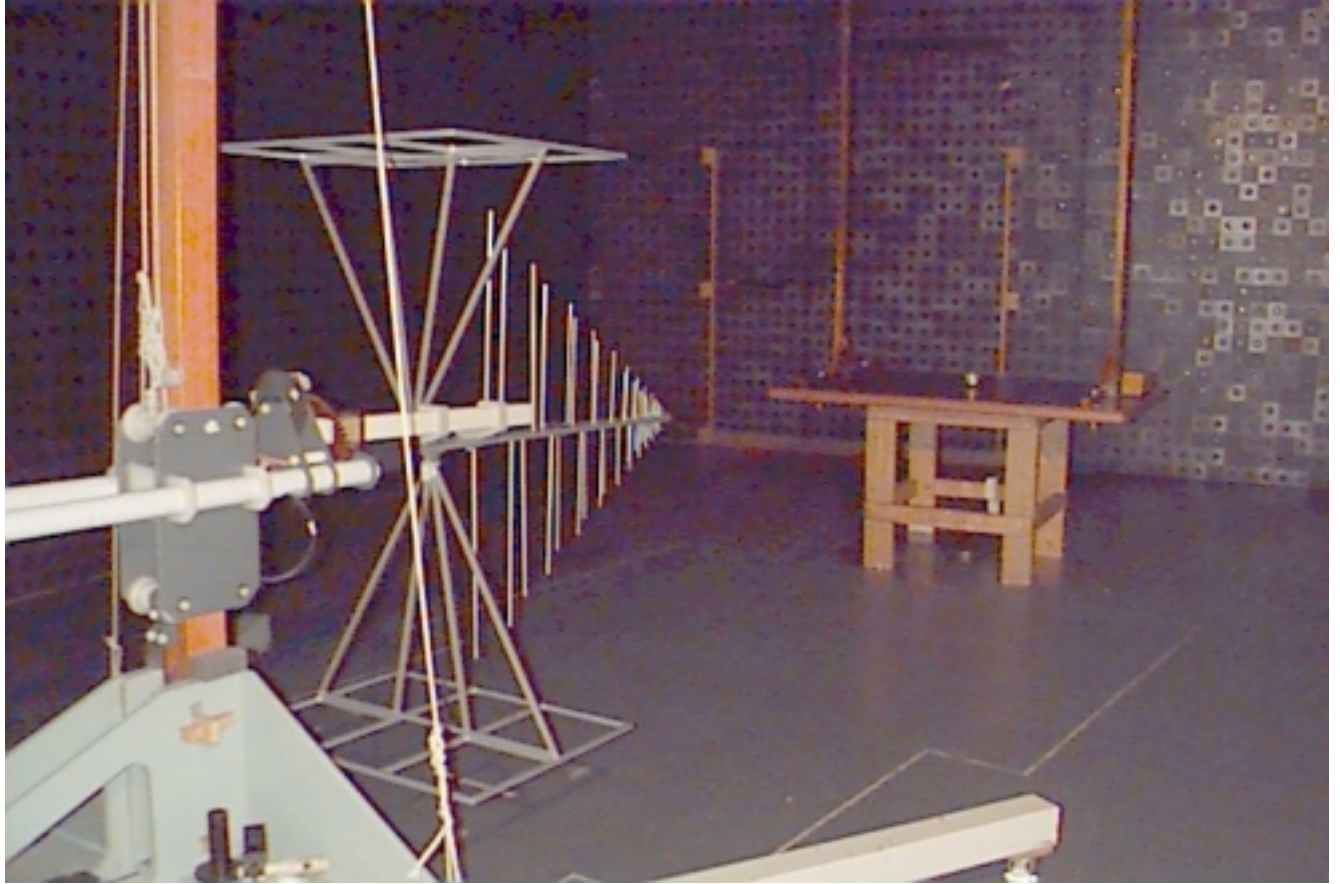
## Appendix B Setup photographs

### SPURIOUS EMISSIONS MEASUREMENTS WITH LOOP ANTENNA





## SPURIOUS EMISSIONS MEASUREMENTS WITH BICONILOG ANTENNA





## SPURIOUS EMISSIONS MEASUREMENTS WITH HORN ANTENNA







## SPURIOUS EMISSIONS MEASUREMENTS, SETUP





## PEAK OUTPUT POWER MEASUREMENTS, SETUP





## Appendix C Example of hopping frequency

**Frequency Hopping Sequence Table**

	<b>Frequency [MHz]</b>	<b>Frequency Assignment</b>
1.	916.2999	F1
2.	913.0274	F2
3.	909.1516	F3
4.	910.3006	F4
5.	907.3999	F5
6.	920.0465	F6
7.	914.7650	F7
8.	913.5562	F8
9.	911.3666	F9
10.	915.6513	F10
11.	917.8524	F11
12.	908.4797	F12
13.	905.6002	F13
14.	922.4692	F14
15.	916.8810	F15
16.	919.1790	F16
17.	912.4007	F17
18.	907.9308	F18
19.	906.6656	F19
20.	910.8174	F20
21.	921.2262	F21
22.	906.1438	F22
23.	923.1750	F23
24.	921.7514	F24
25.	909.7223	F25
26.	914.1498	F26





## Appendix D 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	2/03 Check
0041	Double ridged guide antenna, 1-18 GHz	Electro-Metrics	RGA 50/60	2811	3/03
0446	Active Loop Antenna 10 kHz-30 MHz	Electro-Mechanics	6502	2857	10/02
0465	Anechoic Chamber 9 (L) x 6.5 (W) x 5.5 (H) m	Hermon Labs	AC-1	023	11/02 check
0521	Spectrum Analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz)	Hewlett Packard	8546A	0319	9/02
0554	Amplifier, 2 – 18 GHz RF	Miteq	AFD-4	4300	12/02
0569	Antenna, Log Periodic, 200-1000MHz	Electro-Metrics	LPA 25/30	1953	1/03
0589	Cable Coaxial, GORE A2POL118.2, 3m	Hermon Labs	GORE-3	589	12/02
0590	Attenuator 10 dB, 50 Ohm, N-type, 2W	Elisra Electronic Systems	MW2100-N-Type	10	01/03
0604	Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz	EMCO	3141	9611-1011	01/03
0661	Generator Swept Signal, 10MHz to 40GHz+ 10dBm	Hewlett Packard	83640B	0266	9/02
0812	Cable, coax, RG-214, 11.5 m, N-type connectors	Hermon Labs	C214-11	148	5/03
1004	Cable coaxial, ANDREW PSWJ4, 6 m	Hermon Labs	ANDREW-6	163	12/02
1200	Quadruplexer	Elettronica	UE 84	0240	4/03 check
1424	Spectrum analyzer, 30 Hz - 40 GHz	Agilent Technologies	8564EC	3946A00219	8/02
1430	EMI Receiver System, 9 kHz - 2.9 GHz	Agilent Technologies	8542E	3807A00262	9/02
1552	Cable RF, 8 m	Alpha wire	RG-214	NA	5/03
1565	Antenna, Dipole, Tunable 500 - 1000 MHz	Electro-Metrics	TDS-30-2	334	1/03
1871	Attenuator, 50 Ohm, 2W, DC-8 GHz, 10 dB	Midwest Microwave	ATT 0217-10-NNN-02	NA	01/03
1939	Cable 40 GHz, 1.5 m, green	Rhophase Microwave Ltd.	KPS-1503A-1500-KPS	T4664	10/02
1942	Cable 18 GHz, 4 m, blue	Rhophase Microwave Ltd	SPS-1803A-4000-NPS	T4658	10/02
1947	Cable 18 GHz, 6.5 m, blue	Rhophase Microwave Ltd	NPS-1803A-6500-NPS	T4974	10/02



## Appendix E Test equipment correction factors

### Antenna factor, Active Loop Antenna Model 6502 S/N 2857

Frequency, MHz	Antenna Factor, dB
0.009	-32.8
0.010	-33.8
0.020	-38.3
0.050	-41.1
0.075	-41.3
0.100	-41.6
0.150	-41.7
0.250	-41.6
0.500	-41.8
0.750	-41.9
1.000	-41.4
2.000	-41.5
3.000	-41.4
4.000	-41.4
5.000	-41.5
10.000	-41.9
15.000	-41.9
20.000	-42.2
25.000	-42.8
30.000	-44.0

Antenna factor is to be added to receiver meter reading in dB( $\mu$ V) to convert to field intensity in dB( $\mu$ V)/meter

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

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( $\mu$ V) to convert to field intensity in dB( $\mu$ V)/meter



**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( $\mu$ V) to convert to field intensity in dB( $\mu$ V/meter).



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

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

Antenna factor is to be added to receiver meter reading in dB( $\mu$ V) to convert to field intensity in dB( $\mu$ V)/meter



**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	-			
22		4500	4.07	-		±0.17	
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 18GHz, 4 m, blue, model: SPS-1803A-4000-NPS, s/nT4658 (HL 1942)**  
**Calibration data**

Frequency, GHz	Insertion Loss, dB
	HL1942
0.03	0.21
0.05	0.26
0.10	0.36
0.20	0.50
0.30	0.61
0.40	0.70
0.50	0.78
0.60	0.85
0.70	0.93
0.80	0.99
0.90	1.04
1.00	1.10
1.10	1.16
1.20	1.22
1.30	1.26
1.40	1.31
1.50	1.35
1.60	1.41
1.70	1.45
1.80	1.49
1.90	1.53
2.00	1.57
2.10	1.61
2.20	1.65
2.30	1.69
2.40	1.72
2.50	1.76
2.60	1.79
2.70	1.83
2.80	1.87
2.90	1.90
3.10	1.97
3.30	2.04
3.50	2.11
3.70	2.18
3.90	2.24
4.10	2.31
4.30	2.38
4.50	2.43
4.70	2.53
4.90	2.53
5.10	2.63
5.30	2.65
5.50	2.72
5.70	2.76
5.90	2.79

Frequency, GHz	Insertion Loss, dB
	HL1942
6.10	2.88
6.30	2.90
6.50	2.97
6.70	3.02
6.90	3.04
7.10	3.07
7.30	3.12
7.50	3.13
7.70	3.19
7.90	3.24
8.10	3.30
8.30	3.36
8.50	3.45
8.70	3.41
8.90	3.45
9.10	3.42
9.30	3.55
9.50	3.48
9.70	3.58
9.90	3.61
10.10	3.66
10.30	3.68
10.50	3.70
10.70	3.70
10.90	3.75
11.10	3.78
11.30	3.86
11.50	3.98
11.70	4.10
11.90	4.12
12.10	4.09
12.40	4.13
13.00	4.23
13.50	4.35
14.00	4.40
14.50	4.44
15.00	4.57
15.50	4.66
16.00	4.64
16.50	4.66
17.00	4.75
17.50	4.85
18.00	4.93



## Calibration data, cable HL 1552

Manufacturer	Model	Description	HL Serial No./
Alpha Wire	C-56(RG-214-8m)	Cable RF, 8 m	1552

No.	Parameter	SET	Measured attenuation	Deviation	Tolerance (Specification)	Meas. Uncert.	Notes
1	10 kHz		0.01 dB			±0.05 dB	
2	100 kHz		0.01 dB			±0.05 dB	
3	1 MHz		0.03 dB			±0.05 dB	
4	10 MHz		0.12 dB			±0.05 dB	
5	20 MHz		0.23 dB			±0.05 dB	
6	30 MHz		0.30 dB			±0.05 dB	
7	40 MHz		0.32 dB			±0.05 dB	
8	50 MHz		0.34 dB			±0.05 dB	
9	60 MHz		0.39 dB			±0.05 dB	
10	70 MHz		0.43 dB			±0.05 dB	
11	80 MHz		0.48 dB			±0.05 dB	
12	90 MHz		0.50 dB			±0.05 dB	
13	100 MHz		0.55dB			±0.05 dB	
14	200 MHz		0.78 dB			±0.05 dB	
15	300 MHz		1.04 dB			±0.05 dB	
16	400 MHz		1.16 dB			±0.05 dB	
17	500 MHz		1.33 dB			±0.05 dB	
18	600 MHz		1.51 dB			±0.05 dB	
19	700 MHz		1.65 dB			±0.05 dB	
20	800 MHz		1.77 dB			±0.05 dB	
21	900 MHz		1.92 dB			±0.05 dB	
22	1000 MHz		2.04 dB			±0.05 dB	
23	1200 MHz		2.26 dB			±0.05 dB	
24	1400 MHz		2.49 dB			±0.05 dB	
25	1600 MHz		2.74 dB			±0.05 dB	
26	1800 MHz		2.94 dB			±0.05 dB	
27	2000 MHz		3.18 dB			±0.05 dB	
28	2500 MHz		3.65 dB			±0.05 dB	
29	2900 MHz		4.08 dB			±0.05 dB	



**Calibration data, cable HL 1939**

Frequency, GHz	Insertion Loss, dB				
	HL1936	HL1937	HL1938	HL1939	HL1940
0.03	0.06	0.07	0.07	0.12	0.13
0.05	0.07	0.08	0.09	0.15	0.14
0.10	0.10	0.11	0.11	0.20	0.19
0.20	0.14	0.14	0.15	0.27	0.25
0.30	0.18	0.18	0.19	0.33	0.31
0.40	0.20	0.20	0.22	0.39	0.37
0.50	0.23	0.23	0.24	0.43	0.41
0.60	0.26	0.26	0.28	0.48	0.46
0.70	0.28	0.28	0.30	0.52	0.49
0.80	0.31	0.30	0.32	0.55	0.53
0.90	0.32	0.32	0.34	0.59	0.56
1.00	0.34	0.33	0.35	0.62	0.59
1.10	0.36	0.36	0.38	0.65	0.62
1.20	0.38	0.38	0.39	0.68	0.65
1.30	0.39	0.38	0.40	0.70	0.68
1.40	0.40	0.40	0.42	0.73	0.70
1.50	0.42	0.41	0.43	0.76	0.73
1.60	0.44	0.43	0.45	0.79	0.76
1.70	0.44	0.44	0.45	0.80	0.77
1.80	0.45	0.45	0.46	0.82	0.80
1.90	0.47	0.47	0.48	0.84	0.82
2.00	0.47	0.46	0.48	0.86	0.84
2.10	0.48	0.46	0.49	0.88	0.85
2.20	0.50	0.48	0.50	0.89	0.87
2.30	0.50	0.48	0.51	0.91	0.88
2.40	0.51	0.49	0.52	0.93	0.90
2.50	0.52	0.50	0.53	0.95	0.91
2.60	0.53	0.51	0.54	0.97	0.93
2.70	0.54	0.52	0.55	0.98	0.95
2.80	0.56	0.53	0.56	1.01	0.97
2.90	0.56	0.53	0.56	1.02	0.98
3.10	0.57	0.55	0.58	1.05	1.02
3.30	0.59	0.57	0.60	1.09	1.05
3.50	0.61	0.59	0.62	1.12	1.09
3.70	0.63	0.61	0.64	1.17	1.12
3.90	0.65	0.63	0.66	1.18	1.15
4.10	0.67	0.65	0.69	1.23	1.18
4.30	0.68	0.66	0.69	1.25	1.21
4.50	0.72	0.68	0.71	1.29	1.24
4.70	0.73	0.69	0.76	1.31	1.29
4.90	0.71	0.69	0.75	1.32	1.27



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5.10	0.75	0.71	0.73	1.36	1.33
5.30	0.79	0.73	0.76	1.38	1.33
5.50	0.77	0.74	0.80	1.44	1.38
5.70	0.78	0.79	0.79	1.44	1.41
5.90	0.83	0.79	0.81	1.50	1.43
6.10	0.84	0.81	0.84	1.51	1.50
6.30	0.83	0.87	0.83	1.57	1.47
6.50	0.84	0.85	0.85	1.57	1.56
6.70	0.84	0.82	0.86	1.58	1.50
6.90	0.84	0.87	0.84	1.60	1.53
7.10	0.85	0.85	0.88	1.58	1.53
7.30	0.85	0.82	0.88	1.62	1.56
7.50	0.90	0.87	0.88	1.62	1.59
7.70	0.92	0.88	0.97	1.68	1.62
7.90	0.93	0.89	0.99	1.69	1.68
8.10	0.98	0.92	0.95	1.73	1.67
8.30	0.98	0.91	0.99	1.73	1.70
8.50	0.95	0.94	0.99	1.77	1.69
8.70	0.98	0.93	0.95	1.75	1.70
8.90	0.94	0.89	0.95	1.77	1.68
9.10	0.93	0.93	0.94	1.76	1.70
9.30	1.00	0.93	0.95	1.81	1.70
9.50	0.98	0.92	1.04	1.85	1.77
9.70	1.01	1.00	1.05	1.86	1.80
9.90	1.15	1.03	1.04	1.95	1.88



**Cable loss**  
**Cable RG-214 (0812, 0813)**

Frequency, MHz	Cable Loss,dB		Frequency, MHz	Cable Loss,dB		Frequency, MHz	Cable Loss,dB		Frequency, MHz	Cable Loss,	
	3 m	10 m		3 m	10 m		3 m	10 m		3 m	10 m
30	0.8	0.8	115	1.8	1.8	200	2.5	2.6	625	4.7	5.0
35	0.9	0.9	120	1.8	1.8	225	2.7	2.8	650	4.8	5.2
40	1.0	1.0	125	1.8	1.9	250	2.8	2.9	675	4.9	5.3
45	1.1	1.1	130	1.9	1.9	275	2.9	3.1	700	5.0	5.4
50	1.1	1.1	135	1.9	2.0	300	3.0	3.2	725	5.1	5.6
55	1.2	1.2	140	1.9	2.0	325	3.1	3.4	750	5.2	5.7
60	1.3	1.3	145	2.0	2.1	350	3.3	3.6	775	5.3	5.8
65	1.3	1.3	150	2.0	2.1	375	3.5	3.8	800	5.4	5.9
70	1.4	1.4	155	2.1	2.2	400	3.6	3.9	825	5.6	6.0
75	1.4	1.4	160	2.1	2.2	425	3.7	4.0	850	5.7	6.1
80	1.5	1.5	165	2.2	2.3	450	3.8	4.1	875	5.9	6.2
85	1.5	1.5	170	2.2	2.3	475	3.9	4.2	900	6.0	6.3
90	1.6	1.6	175	2.3	2.4	500	4.0	4.3	925	6.1	6.4
95	1.6	1.6	180	2.3	2.4	525	4.1	4.4	950	6.2	6.5
100	1.7	1.7	185	2.4	2.5	550	4.2	4.6	975	6.3	6.6
105	1.7	1.7	190	2.5	2.6	575	4.4	4.8	1000	6.4	6.7
110	1.7	1.7	195	2.5	2.6	600	4.6	4.9			



## Appendix F General information

### 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 TNO Certification EP&S (Netherlands) for a number of EMC, Telecommunications, 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).

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### 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( $\mu$ V)	decibel referred to one microvolt
dB( $\mu$ 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
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

### 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.