HERMON LABORATORIES

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839.01
Electrical

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ELECTROMAGNETIC EMISSION TEST REPORT

ACCORDING TO 47CFR PART 15, SUBPART C § 15.249 and SUBPART B

for

On Track Innovations Ltd.

EQUIPMENT UNDER TEST:

VST tag

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Contents

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1 Project information

Description of equipment under test

Test items	:VST tag
Manufacturer	:On Track Innovations Ltd.
Types (Models)	:MCI2-3 QSR
Equipment FCC code[1]	:DXX

Applicant information

Applicant's responsible person	:Mr. Hemi Itay, project manager
Company	: On Track Innovations Ltd.
Address	:Zahar industrial zone,
Postal code	:12000
City	:Rosh Pina
Country	:Israel
Telephone number	:+972 4 6868000
Telefax number	:+972 4 6938887

Test performance

Project Number:	:14915
Location	:Hermon Laboratories
Receipt date	:December 12, 2001
Test started	:December 12, 2001
Test completed	February 11, 2002
Purpose of test	Apparatus compliance verification in accordance with emission requirements
Test specification(s)	47CFR Part 15, §15.249 and subpart B

[1] FCC Equipment codes – see Appendix D

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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, §15.225, §15.249 and subpart B.

Parameter	Subclause	C	NC	NT	NA	Tested by	Date tested	Remarks
Transmitter characteristics, §15.249								
Field strength of fundamental	(a)	**C**				Mr. Y Neuman, test engineer	Jan-17-2002	
Field strength of harmonics	(a)	**C**				Mr. Y Neuman, test engineer	Jan-17-2002	
Out of band spurious emissions (radiated)	(c)	**C**				Mr. Y Neuman, test engineer	Jan-17-2002, Feb-11-2002	
Unintentional radiation, §15.107, §15.109								
Conducted emissions	15.107				**NA**			
Radiated emissions	15.109	**C**				Mrs. E Pitt, test engineer	Dec-11-2001	
Receiver characteristics, §15.109								
Spurious radiated emissions	15.109	**C**				Mrs. E Pitt, test engineer	Dec-11-2001	

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Parameter	Subclause	C	NC	NT	NA	
General conditions under Part 15						
The Intentional radiator operates at 915 MHz frequency.	15.249	**C**				
The intentional radiator has permanently attached antenna or antenna that uses a unique coupling to the intentional radiator.	15.203	**C**				
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				**NA**	
No antenna other than that furnished by the responsible party can be used with the device.	15.203					Responsibility of the end user
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, certification engineer

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

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3 EUT description

3.1 General description

The VST/PST system comprises three elements:

- VST/PST Controller;
- VST (Vehicle Smart Tag) tag;
- PST (Portable Smart Tag) tag.

The VST portion of the system supports communication between the VST tag and the controller over distances of up to few tens of meters, utilizing 915MHz communication frequency.
The system is used to perform “transaction” of data between the VST or PST tags and the controller for various applications.

The VST tag is powered from 3.6 V battery.

3.2 EUT test configuration

The EUT test configuration is provided in Figure 3.2.1. Test configuration of the whole system is shown in Figure 3.2.2.

Figure 3.2.1 EUT test configuration

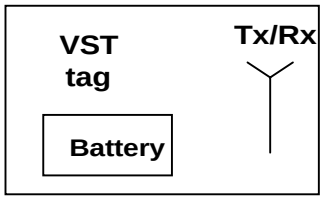

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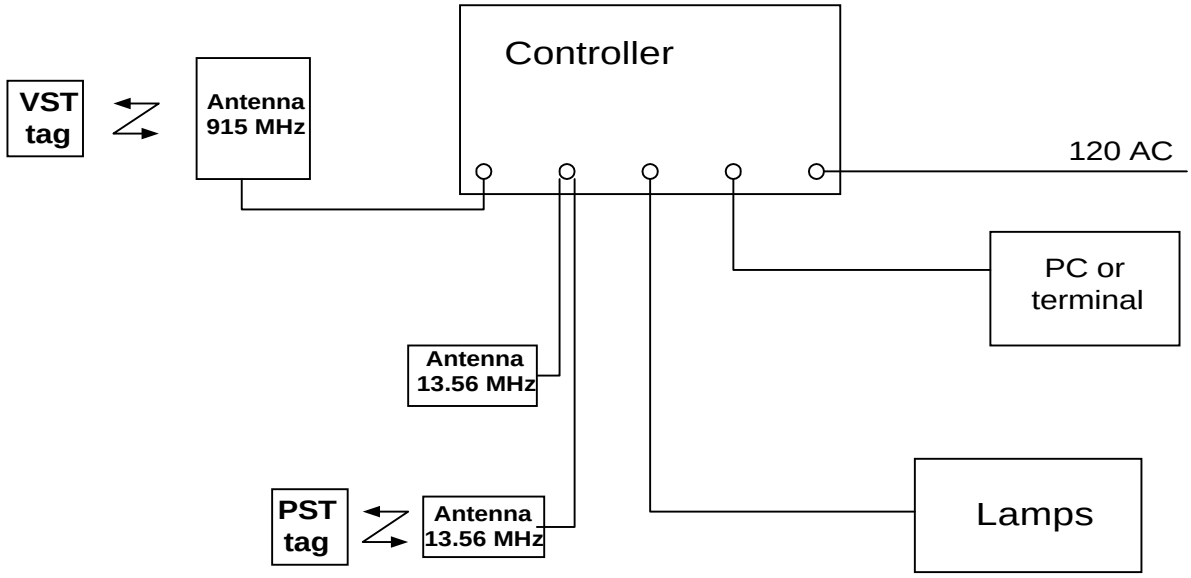
Figure 3.2.2 Test configuration of the whole system



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3.3 Transmitter description

VST tag

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)						
	Other:						
Operating frequency	915 MHz						
Transmitter aggregate data rate (bits per second)	4.8kb/s						
Normal test signal	normal send-message/get-response sequence in a repetitive mode						
Maximum rated output power							
	At transmitter permanent external 50 Ω rf output connector (dBm)						
	Effective radiated power (for equipment with integral antenna) (dBm)	-13 dBm					
	Is transmitter output power variable?		No				
		X	Yes		continuous variable		
				X	stepped variable		
				X	stepsize (dB): 1dB		
				X	minimum RF power (dBm):-.23dBm		
				X	maximum RF power (dBm): -13dBm		
Transmitter power source							
X	**Battery**	**Nominal rated voltage (VDC)**	**3.6**				
	Nickel Cadmium						
X	Lithium						
	Other						
	DC	**Nominal rated voltage (VDC)**					
	AC mains	**Nominal rated voltage (VAC)**	60 Hz				
Is there common power source for transmitter and receiver			**X**	yes		no	

Antenna technical characteristics						
			Type	**Manufacturer**	**Model number**	**Gain**
Integral		with temporary RF connector	**"L"** Shape PCB Trace	--------	---------	------
	X	without temporary RF connector				
External						
External antenna connection – NA						
	standard connector			unique coupling		

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4 Tests results

4.1 Field strength of fundamental according to § 15.249 (a), §15.209

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.4
EQUIPMENT UNDER TEST	VST tag
MODE OF OPERATION	Tx
DATE:	January 17, 2002
RELATIVE HUMIDITY:	43 %
AMBIENT TEMPERATURE:	21°C
OPERATING FREQUENCY RANGE	902-928 MHz

Peak detector

Carrier frequency, MHz	Field strength, dB(µV/m)	Quasi-peak limit, dB(µV/m)	Margin, dB	Reference to Plots in Appendix A
915.0	80.2	94	13.8	A1
Measurement uncertainty, dB		+5.73.dB / -5.57 dB		

TEST EQUIPMENT USED:

HL 0034	HL 0038	HL 0415	HL 0812	HL 1430		

LIMIT

Operating frequency range, MHz	Field strength of fundamental, dB(µV/m)
902-928	94
2400-2483.5	94
5275-5850	94
24000-24250	107.95

For frequencies above 1000 MHz, the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

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4.2 Field strength of harmonics according to § 15.249 (a), §15.209

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.4
EQUIPMENT UNDER TEST	VST tag
MODE OF OPERATION	Tx+Rx
DATE:	December 11, 2001
RELATIVE HUMIDITY:	56 %
AMBIENT TEMPERATURE:	23 °C
FREQUENCY RANGE	1000 – 9500 MHz
CARRIER FREQUENCY	915.3 MHz
EIRP at which the measurements were performed	80.2 dB(μV/m)

Peak detector

Harmonic, MHz	Field strength, dB(μV/m)	Average limit, dB(μV/m)	Margin, dB	Reference to Plots in Appendix A
1830	50.66	54	3.34	A2
2745	45.74	54	8.26	A3
Measurement uncertainty, dB		+5.73.dB / -5.57 dB		

Test results obtained using peak detector were found below average limit, therefore further measurements with average detector were considered unnecessary.

TEST EQUIPMENT USED:

HL 0041	HL 0521	HL 0589	HL 0604	HL 1004		

LIMIT

Operating frequency range, MHz	Field strength of harmonics, dB(μV/m)	
	Peak limit	Average limit
902-928	74	54
2400-2483.5	94	74
5275-5850	94	74
24000-24250	107.95	87.95

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4.3 Out of band spurious emissions according to § 15.249 (c)

METHOD OF MEASUREMENTS	ANSI 63.4 §13.1.4/ §13.1.5
EQUIPMENT UNDER TEST	VST tag
MODE OF OPERATION	Tx + Rx
DATE:	December 11– 12, 2001
RELATIVE HUMIDITY:	59 %
AMBIENT TEMPERATURE:	23 °C
RATED CARRIER FIELD STRENGTH	80.2 dB(μV/m)
TEST DISTANCE	3 m
OPERATING FREQUENCY RANGE	902-928
FREQUENCY RANGE*	9 kHz – 9.5 GHz

Peak detector

Frequency, MHz	Antenna polarization	Radiated emission, dB (μV/m)	Limit, dB(μV/m)	Margin, dB	Reference to Plots in Appendix A
0.09 – 0.15	V	No spurious emissions were found			A4
0.15 – 30	V	No spurious emissions were found			A5
30 – 902	V+H	No spurious emissions were found			A6
890 – 914	V+H	No spurious emissions were found			A7
917 – 1000	V+H	No spurious emissions were found			A8
1000 – 2000	V+H	No spurious emissions were found except harmonics			A9
2000 – 5000	V+H	No spurious emissions were found except harmonics			A10
5000 – 6500	V+H	No spurious emissions were found			A11
6500 – 9500	V+H	No spurious emissions were found			A12
Measurement uncertainty, dB		+5.73.dB / -5.57 dB			

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

TEST EQUIPMENT USED:

HL 0038	HL 0041	HL 0446	HL 0521	HL 0539	HL 0554	HL 0589
HL 0604	HL 1004	HL 1424	HL 1942			

LIMIT

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

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4.4 Receiver spurious emissions, according to §15.109

METHOD OF MEASUREMENT:	ANSI 63.4 §11.6 / ANSI 63.4 §12.1.4
EQUIPMENT UNDER TEST	VST tag + Controller + PST tag
TEST PERFORMED IN:	ANECHOIC CHAMBER
DATE	December 11, 2001
RELATIVE HUMIDITY	59 %
AMBIENT TEMPERATURE:	23 °C
DISTANCE BETWEEN ANTENNA AND EUT:	3 m
THE EUT WAS TESTED AS:	TABLE-TOP
RECEIVER OPERATING FREQUENCIES	915 MHz
FREQUENCY RANGE:	30 MHz – 1 GHz

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
500 – 1000	5000
Above 1000	5^{th} harmonic of the highest frequency or 40 GHz, whichever is lower

Frequency, MHz	**Radiated emissions, dB (µV/m)**	**Limit, dB (µV/m)**	**Margin, dB**	**Reference to Plots in Appendix A**
30-1000	All emissions were found more than 15 dB below the limit			A13, A14
Measurement uncertainty, dB	+5.73.dB / -5.57 dB			

Table abbreviations:
Antenna polarization: V = vertical, H = horizontal
Turntable position: 0^{o} = EUT front panel faces the receiving antenna

TEST EQUIPMENT USED:

HL 0038	HL 0521	HL 0539	HL 0554	HL 0589	HL 0604	HL 1004
HL 1424	HL 1942					

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

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4.5 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	December 11, 2001
RELATIVE HUMIDITY	59%
AMBIENT TEMPERATURE:	23 °C
DISTANCE BETWEEN ANTENNA AND EUT:	3 m
THE EUT WAS TESTED AS:	TABLE-TOP
FREQUENCY RANGE:	30 MHz – 1 GHz
DETECTOR TYPE:	QUASI-PEAK
RESOLUTION BANDWIDTH:	120 kHz

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
500 – 1000	5000
Above 1000	5^{th} harmonic of the highest frequency or 40 GHz, whichever is lower

The limits for class B unintentional radiated emissions were used while testing the equipment in Rx mode, refer to paragraph 4.4 and Plots A13, A14.

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

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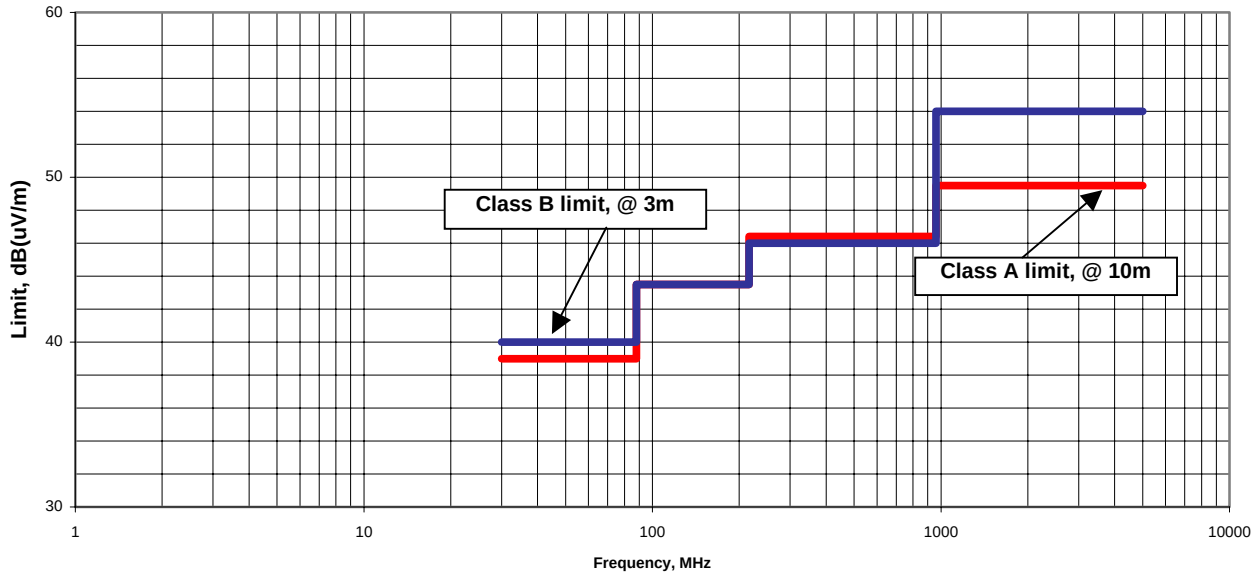
Unintentional radiated emissions test according to §15.109



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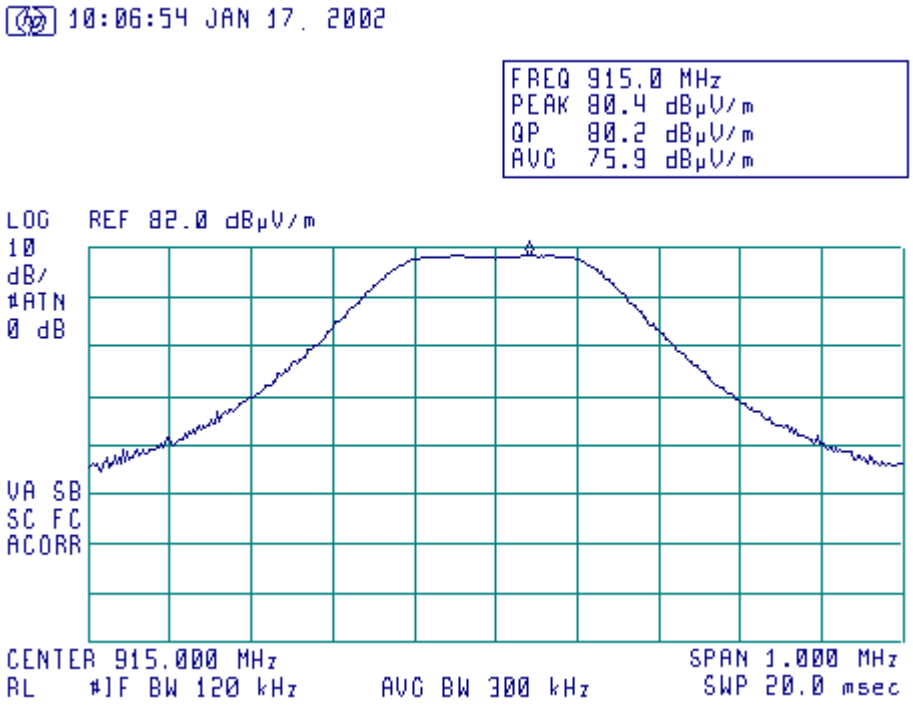
Appendix A Plots

Plot A1 Field strength of fundamental



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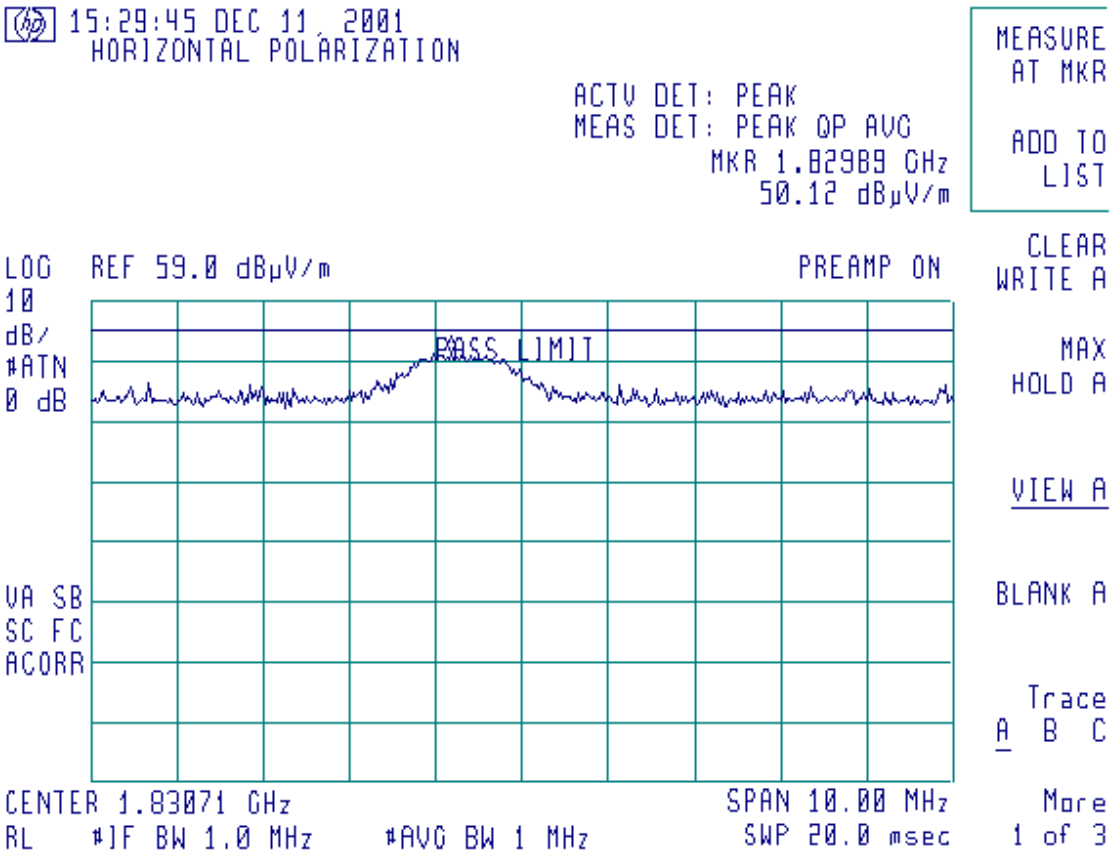
Plot A2 Field strength of harmonics,
2nd harmonic



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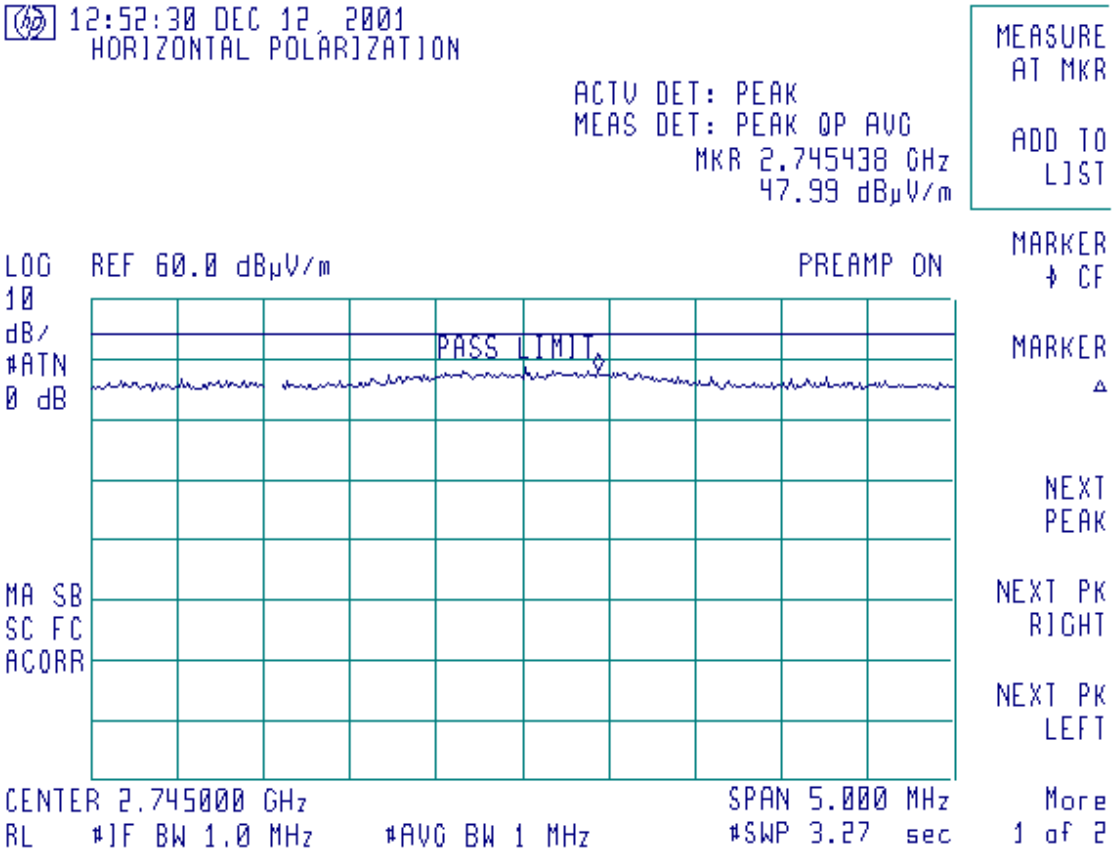
Plot A3 Field strength of harmonics,
3rd harmonic



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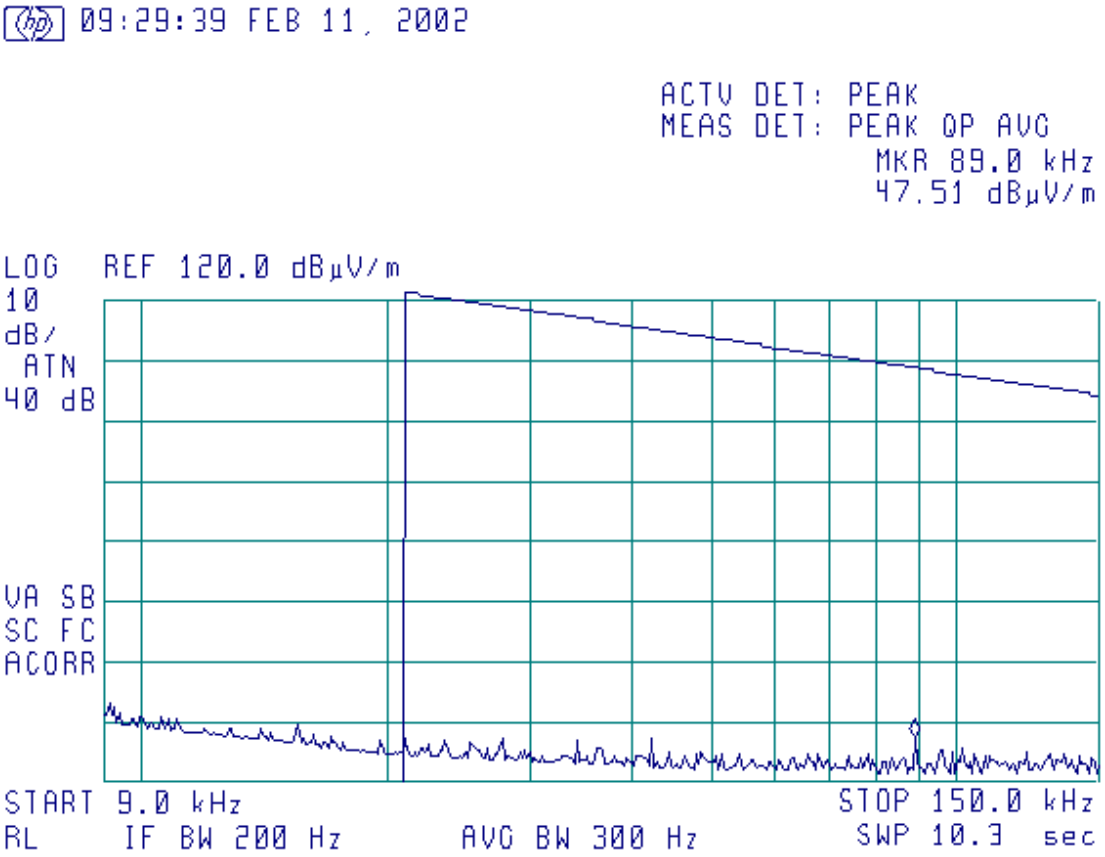
Plot A4 Field strength of out of band emissions,
9 kHz – 150 kHz frequency range



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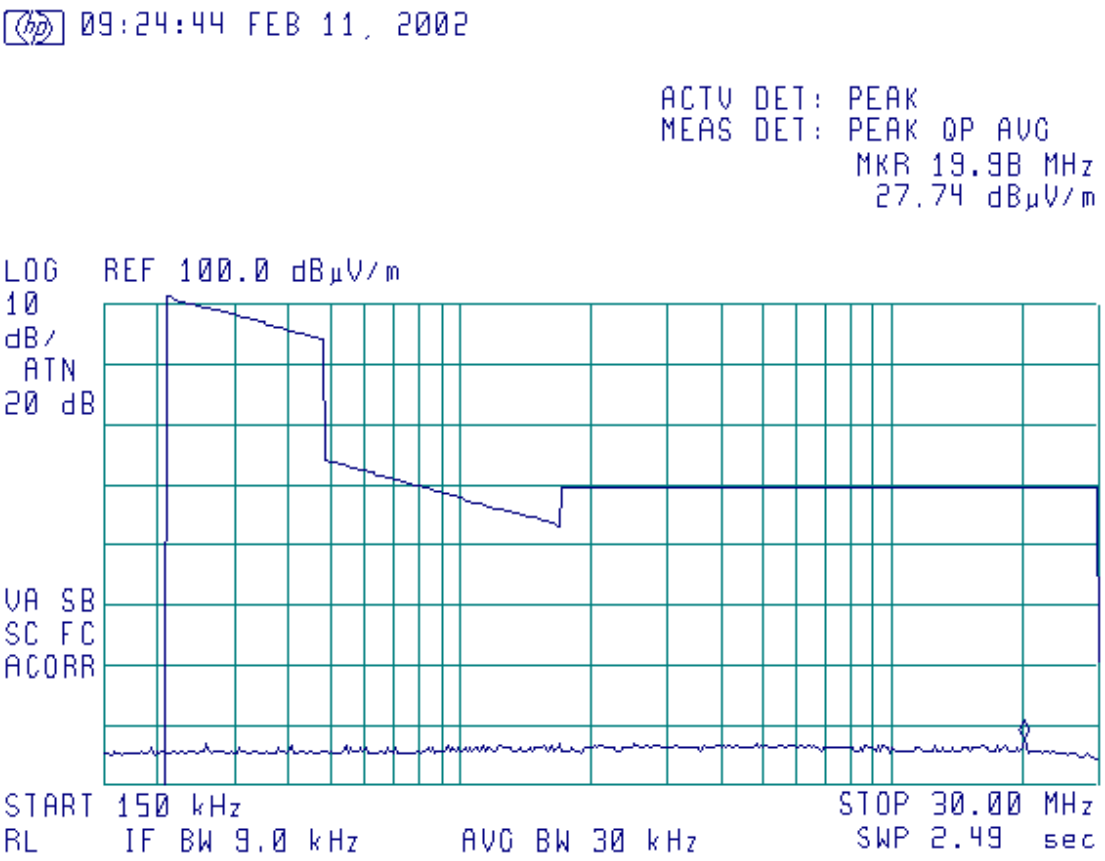
**Plot A5 Field strength of out of band emissions,
150 kHz – 30 MHz frequency range**



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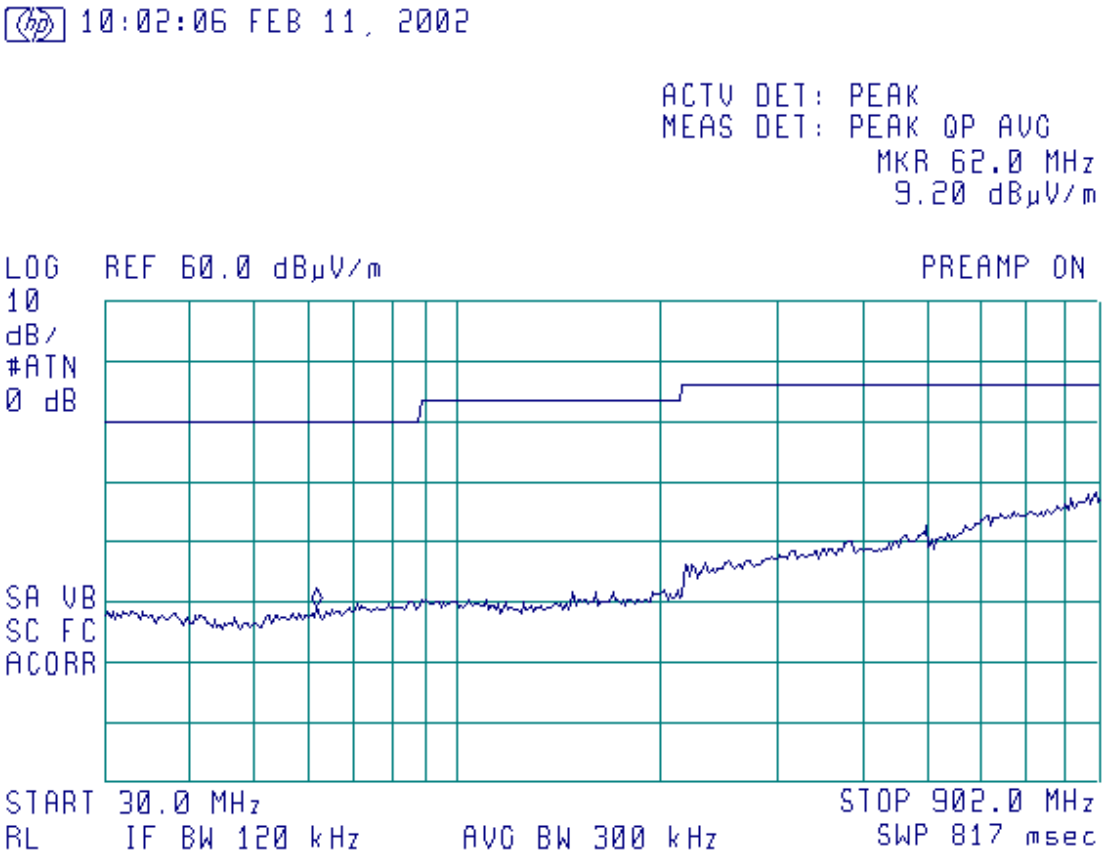
Plot A6 Field strength of spurious emissions,
30 – 902 MHz frequency range, vertical + horizontal polarization



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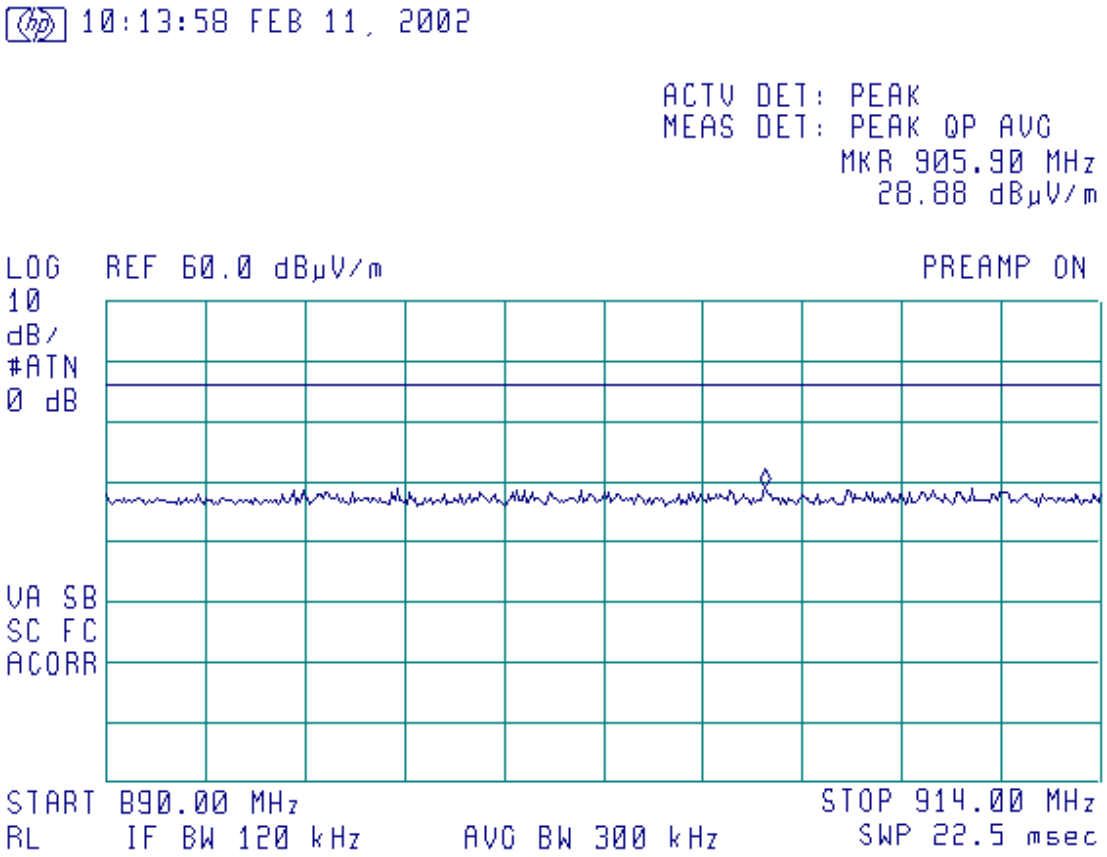
Plot A7 Field strength of spurious emissions,
890 – 914 MHz frequency range, Vertical + horizontal polarization



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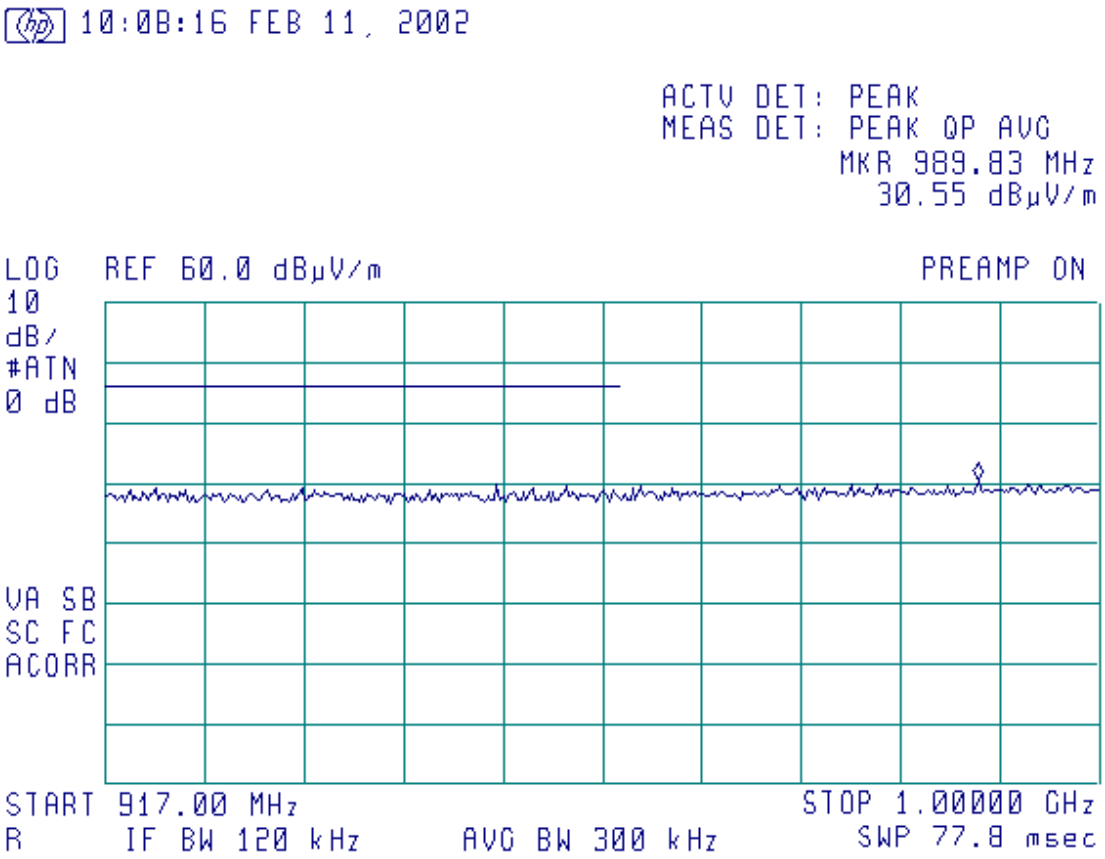
Plot A8 Field strength of spurious emissions,
917 – 1000 MHz frequency range, Vertical + horizontal polarization



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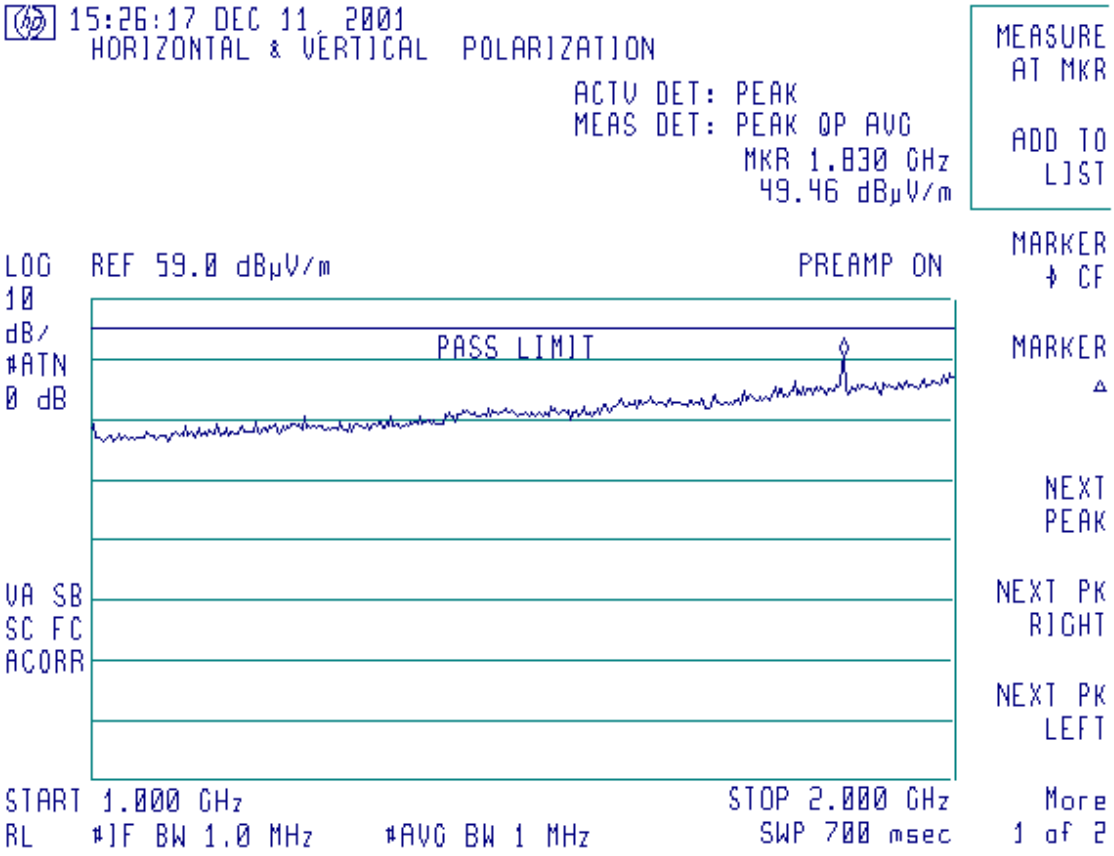
Plot A9 Field strength of spurious emissions,
1 – 2 GHz frequency range, vertical + horizontal polarization



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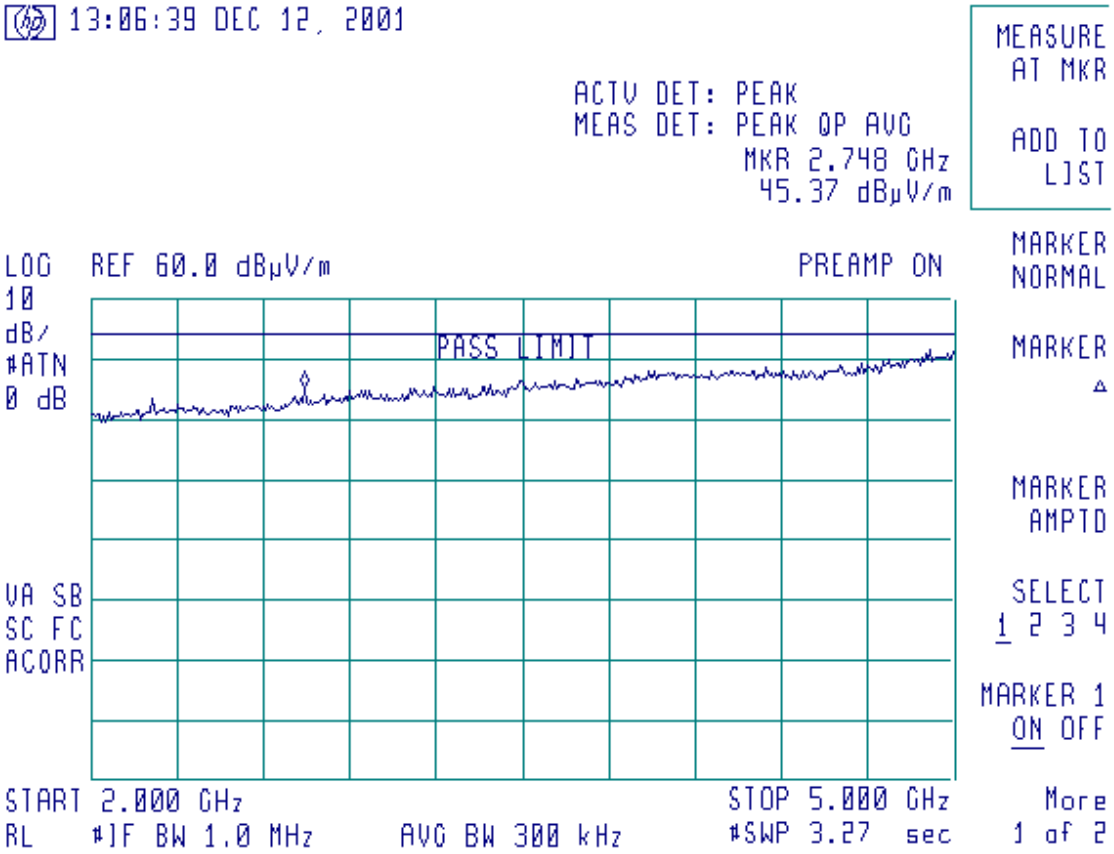
Plot A10 Field strength of spurious emissions,
2 – 5 GHz frequency range, vertical + horizontal polarization



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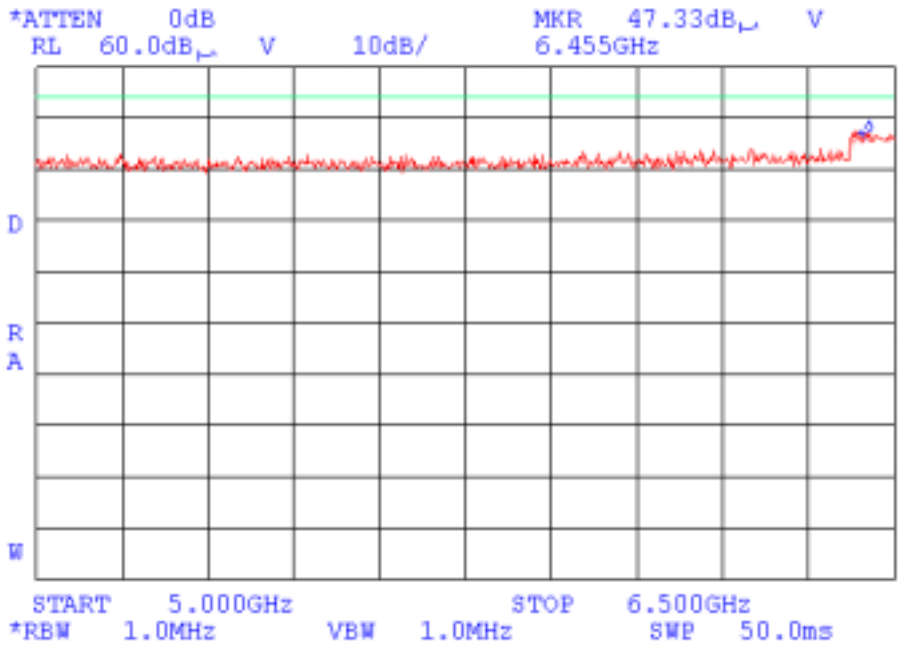
Plot A11 Field strength of spurious emissions,
5 – 6.5 GHz frequency range, vertical + horizontal polarization



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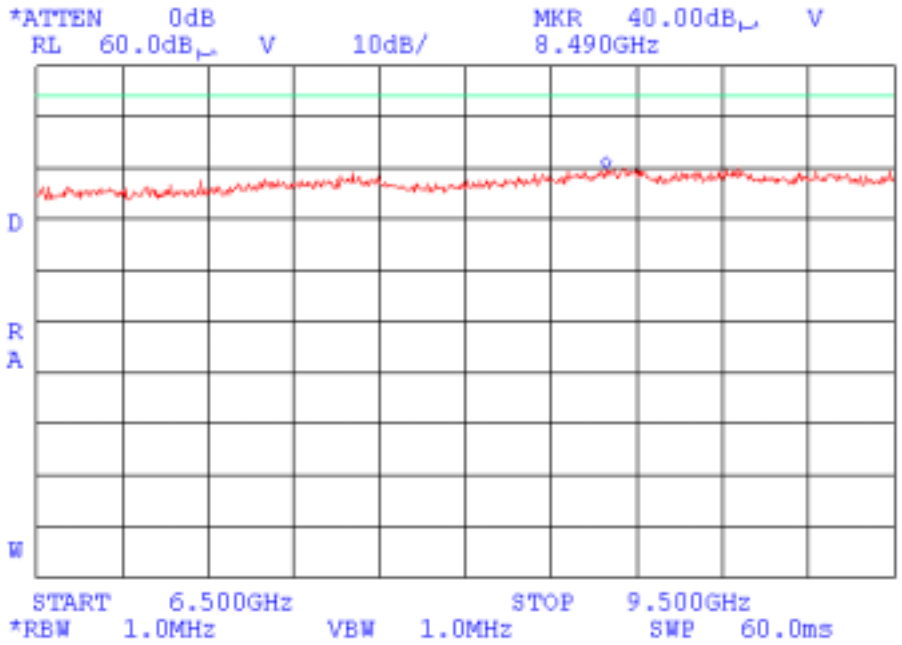
Plot A12 Field strength of spurious emissions,
6.5 – 9.5 GHz frequency range, vertical + horizontal polarization



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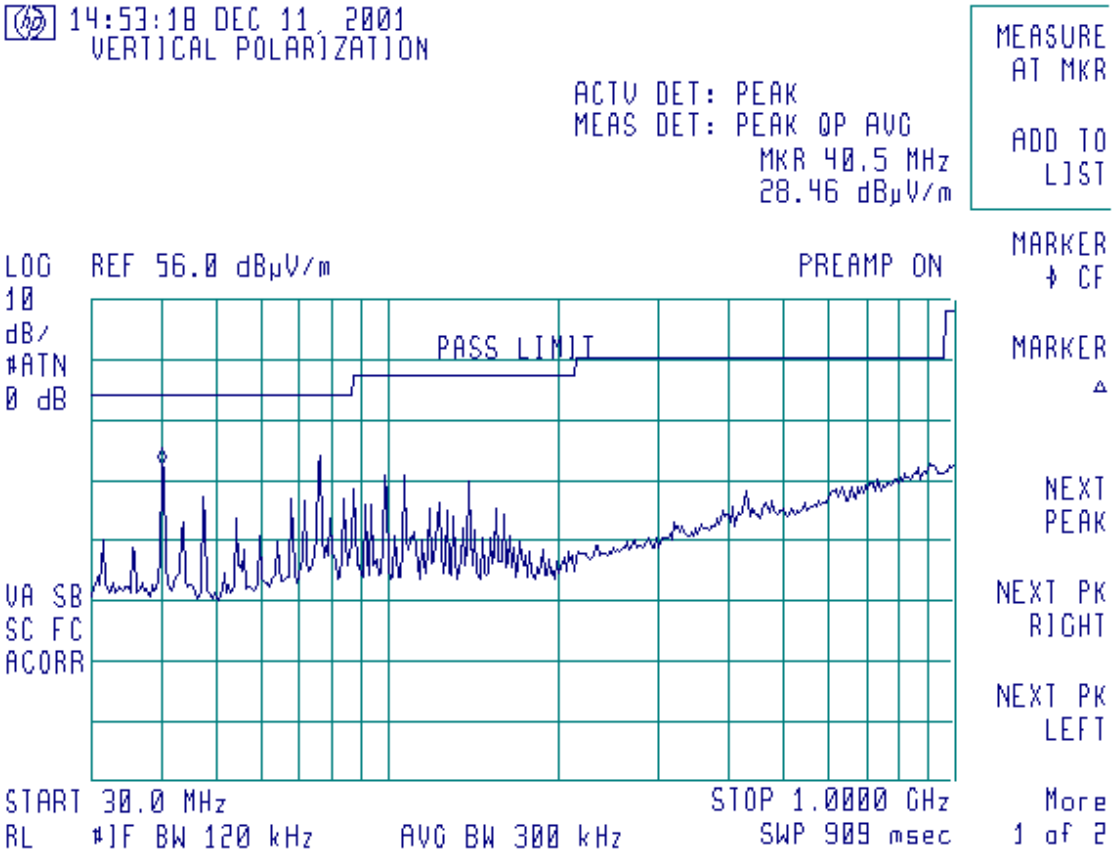
Plot A13 Receiver spurious emissions,
30 – 1000 MHz frequency range, vertical polarization



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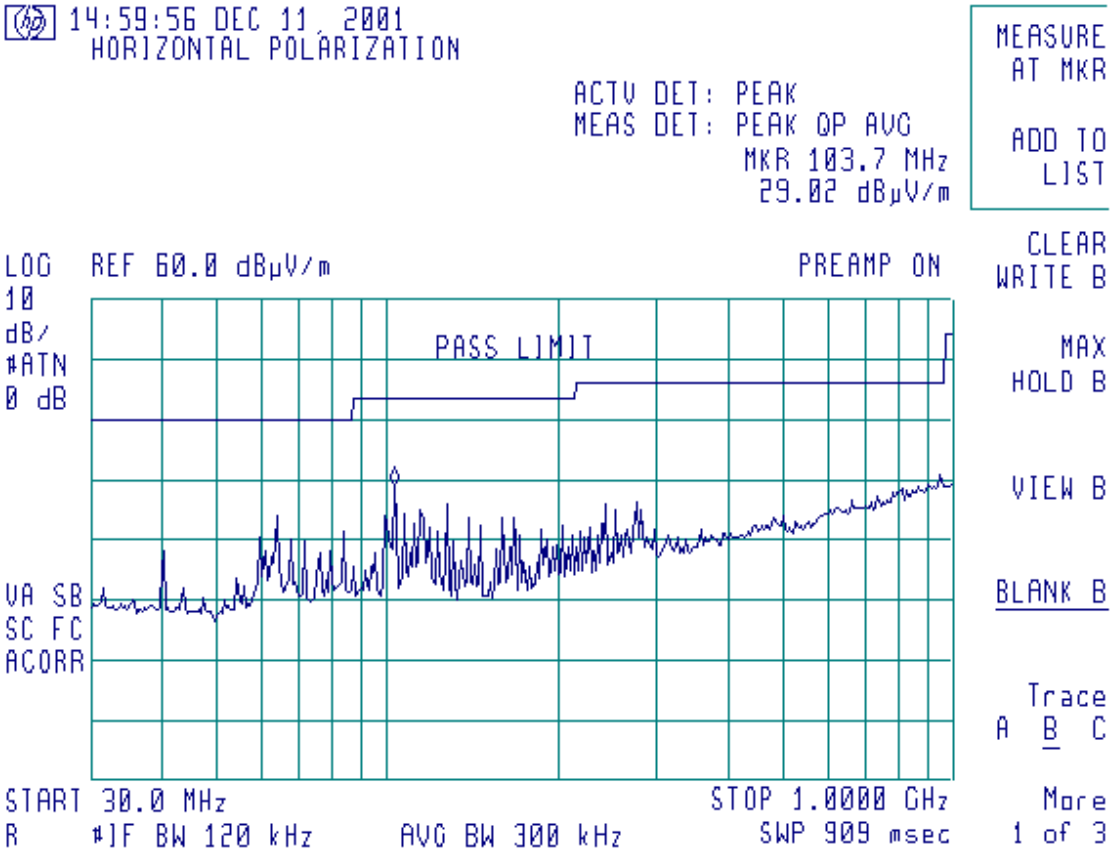
Plot A14 Receiver spurious emissions,
30 – 1000 MHz frequency range, horizontal polarization



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Appendix B Test setup photographs

Photograph 1 Field strength of harmonics, OATS method

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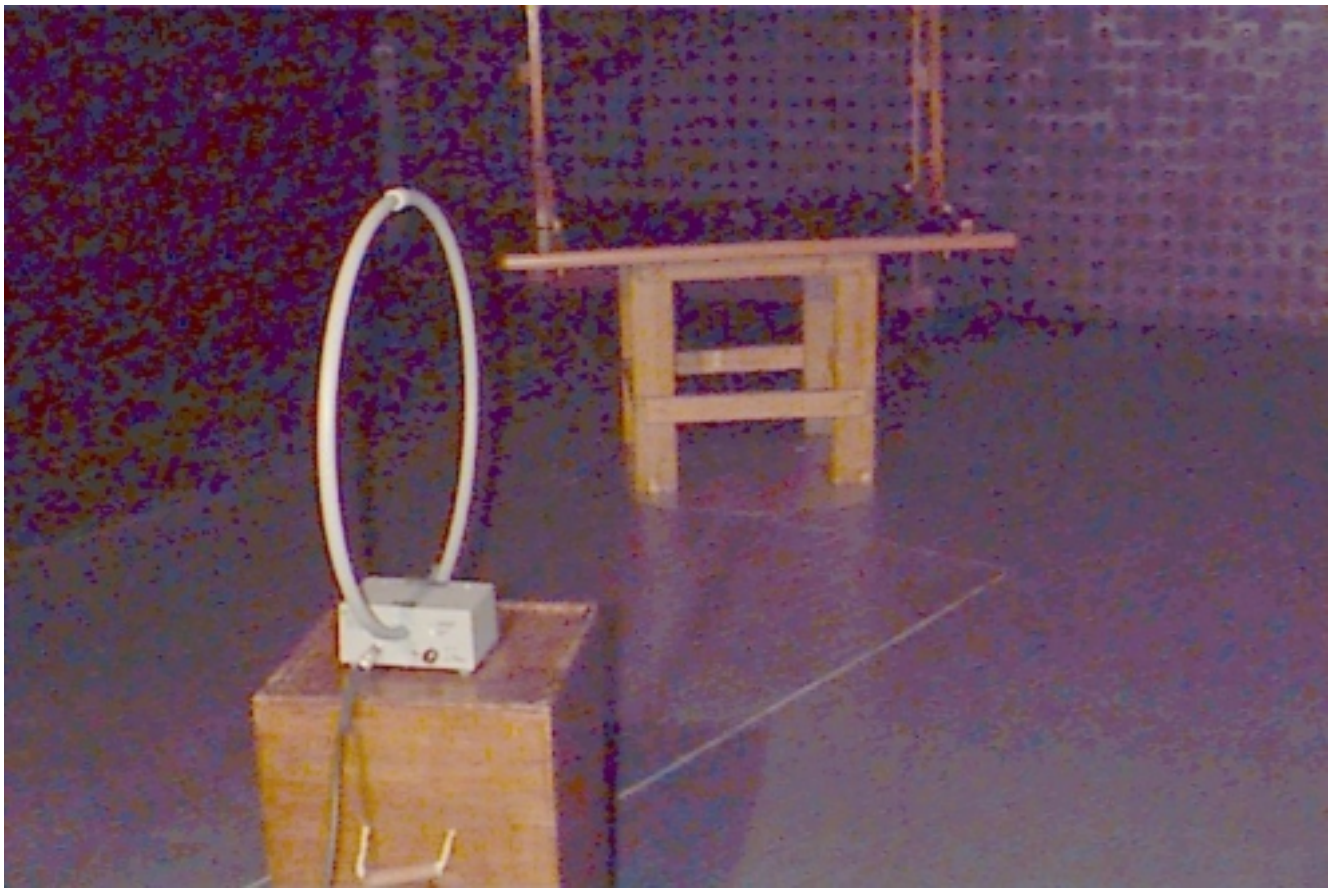
Photograph 2 Tx radiated emission measurements test setup with loop antenna, 9 kHz – 30 MHz frequency range, anechoic chamber method



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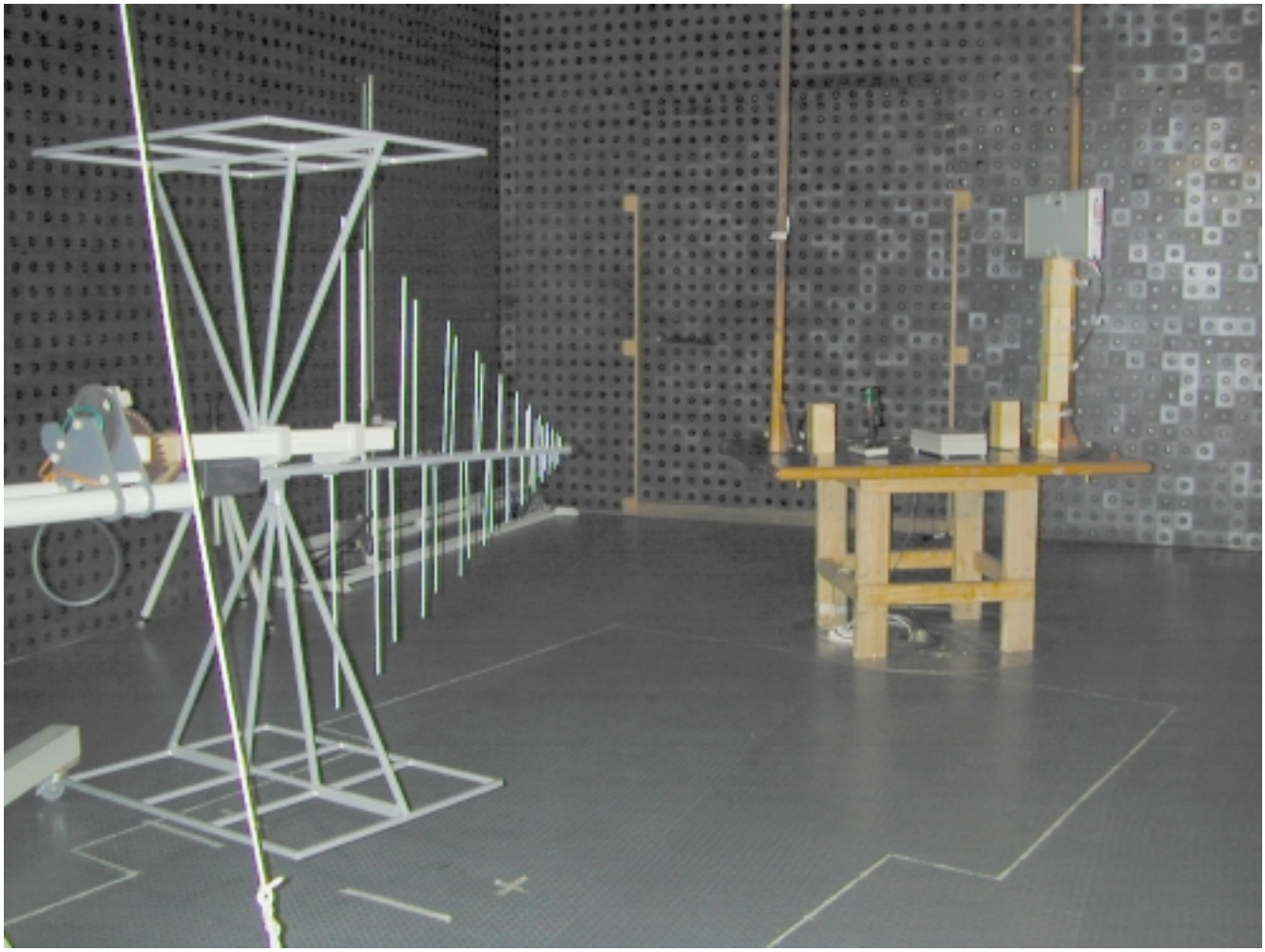
Photograph 3 Rx radiated emission measurements test setup with biconilog antenna, 30 MHz – 1000 MHz frequency range, anechoic chamber method



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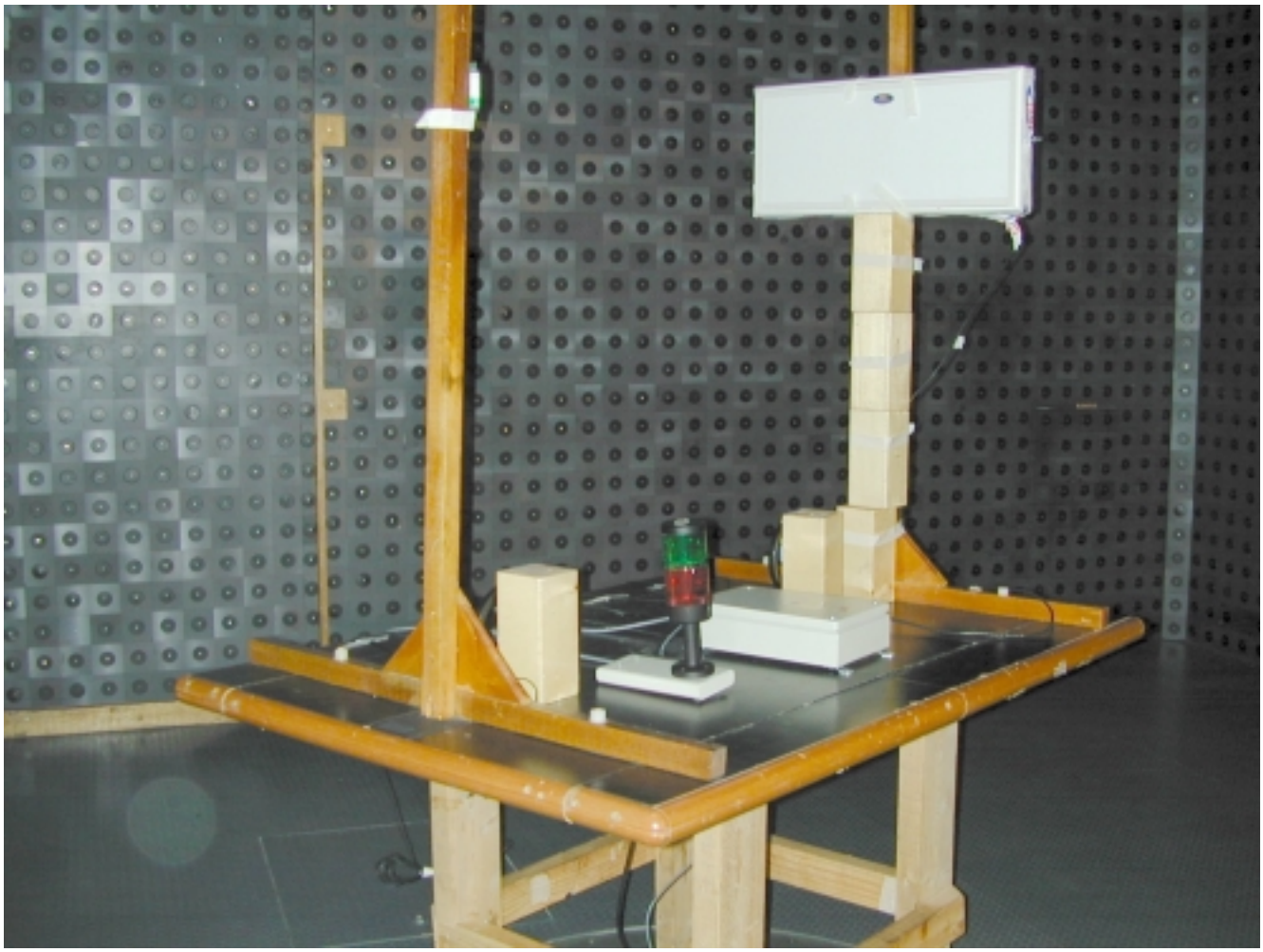
Photograph 4 Radiated emission measurements test setup with biconilog antenna, 30 MHz – 1000 MHz frequency range, anechoic chamber method



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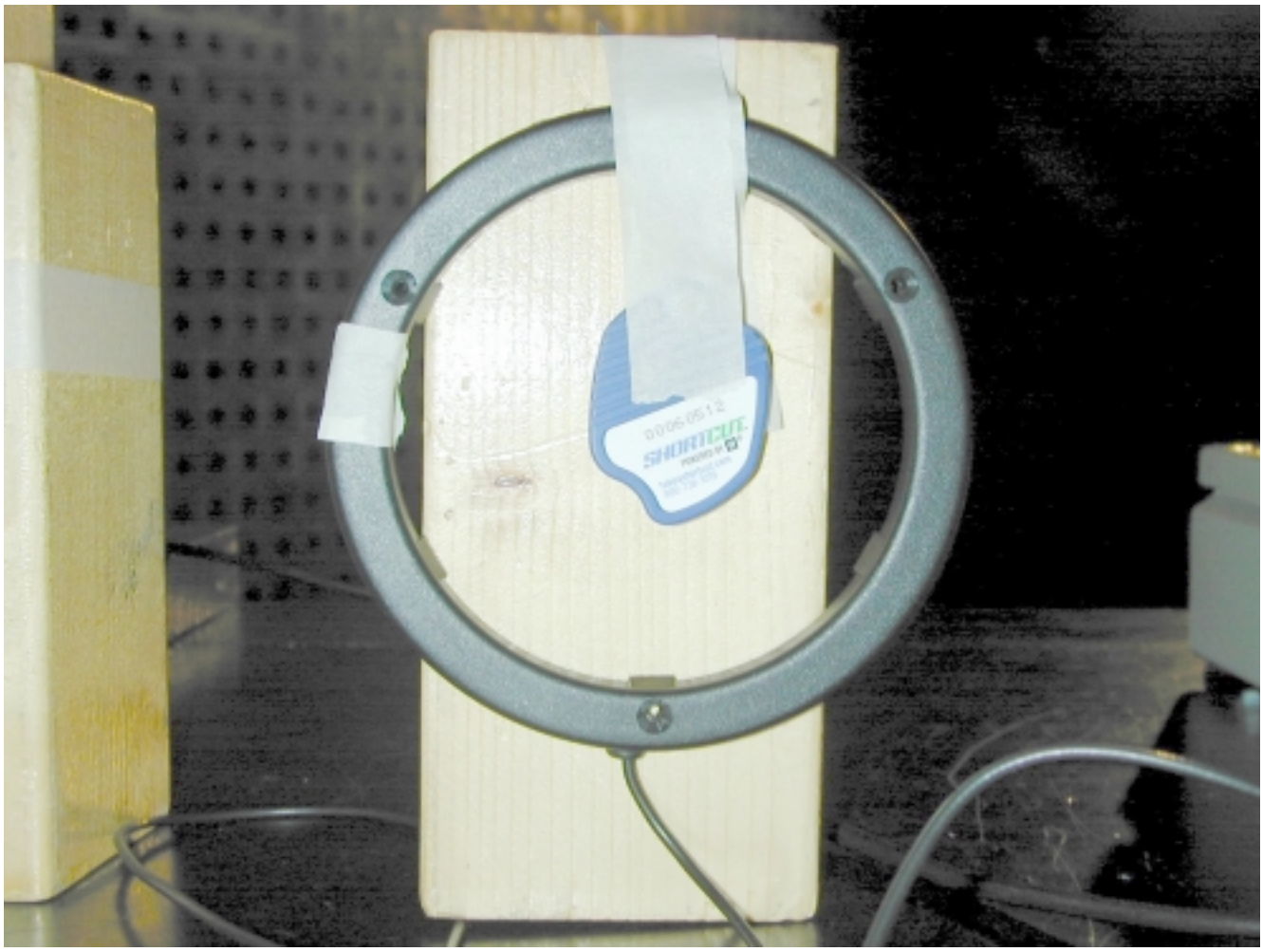
Photograph 5 Radiated emission measurements test setup with biconilog antenna, 30 MHz – 1000 MHz frequency range, anechoic chamber method



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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.	
0034	Log periodic antenna, 200 - 1000 MHz	Electro-Metrics	LPA 25/30	1988	1/03
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	8/02
0415	Cable coax RF, RG-58,	Hermon Labs	CC-3	056	10/02
0446	Active Loop Antenna 10 kHz-30 MHz	Electro-Mechanics	6502	2857	11/02
0521	Spectrum Analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz)	Hewlett Packard	8546A	0319	7/02
0539	Generator Signal	Marconi Instruments	52023-001H	1041	10/02
0554	Amplifier, 2 – 18 GHz RF	Miteq	AFD-4	4300	12/02
0589	Cable Coaxial, GORE A2POL118.2, 3m	Hermon Labs	GORE-3	589	11/02
0604	Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz	EMCO	3141	9611-1011	12/02
0812	Cable, coax, RG-214, 11.5 m, N-type connectors	Hermon Labs	C214-11	148	8/02
1004	Cable coaxial, ANDREW PSWJ4, 6 m	Hermon Labs	ANDREW-6	163	12/02
1424	Spectrum analyzer, 30 Hz - 40 GHz	Agilent Technologies	8564EC	3946A00219	9/02
1430	EMI Receiver System, 9 kHz - 2.9 GHz	Agilent Technologies	8542E	3807A00262	9/02
1942	Cable 18 GHz, 4 m, blue	Rhophase Microwave Ltd	SPS-1803A-4000-NPS	T4658	10/02

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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 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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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
AE	auxiliary equipment
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μV)	decibel referred to one microvolt
dB(μV/m)	decibel referred to one microvolt per meter
EMC	electromagnetic compatibility
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.

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FCC Equipment codes and descriptions

CYY	Communications Receiver used w/ P.15 transmitter
DCD	Part 15 Low Power transmitter Below 1705 kHz
DSC	Part 15 Security/Remote Control Transmitter
DSR	Part 15 Remote Control/Security Device Transceiver
DSS	Part 15 Spread Spectrum Transmitter
DXX	Part 15 Low Power Communication Device Transmitter
EAV	Part 15 Automatic Vehicle Identification System
ETB	Part 15 Cordless Telephone Base Transceiver
ETR	Part 15 Cordless Telephone Remote Transceiver
ETS	Part 15 Cordless telephone system
FAP	Part 15 Anti-Pilferage Device
FDS	Part 15 Field Disturbance Sensor
GAT	Part 15 Auditory Assistance Device (Transmitter)
HID	Part 15 TV Interface Device
JBC	Part 15 Class B Computing Device/ Personal Computer
JBP	Part 15 Class B Computing Device Peripheral
PUB	Part 15 Unlicensed PCS base station
PUE	Part 15 Unlicensed PCS portable Tx held to ear
PUF	Part 15 Unlicensed PCS portable Tx held to face
PUT	Part 15 Unlicensed PCS portable Tx worn on body