HERMON LABORATORIES

ACCREDITED
839.01
Electrical

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ELECTROMAGNETIC EMISSION TEST REPORT

ACCORDING TO 47CFR PART 15, SUBPART B § 15.109 AND SUBPART C § 15.249

for

Tadiran Telematics Ltd.

EQUIPMENT UNDER TEST:

TransMeterWater

TMW-L

Document ID: TADRAD_FCC.14775.doc
Date of Issue: December 00

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Description of equipment under test

Test items	TransMeter Water
Manufacturer	Tadiran Telematics Ltd.
Serial number	NA
Types (Models)	TMW-L
Receipt date	August 19, 2001

Applicant information

Applicant's representative	Mr. Genik Anatoly
Applicant's responsible person	Mr. Hanan Raviv, project manager
Company	Tadiran Telematics
Address	26 Hashoftim Street
P.O.Box	267
Postal code	58102
City	Holon
Country	Israel
Telephone number	+972 35575773
Telefax number	+972 35575753

Test performance

Project Number:	14775
Location	Hermon Laboratories
Test performed	August 19, September 5, 2001
Purpose of test	Apparatus compliance verification in accordance with EMC requirements
Test specifications	47CFR part 15, subpart B, §15.109, subpart C, §15.249, §15.209

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1 Summary and signatures

The tests listed in the table below were performed.[1] The EUT was found complying with the 47CFR part 15:2001, subpart B, §.15.109 and subpart C, §.15.249 standard requirements.

Standard ref.	Report ref.	Method	Ports tested	Tested by	Date tested	P/F/NA/NT[2]	Rationale
Emissions							
Field strength of emission							
47CFR part 15, § 15.249, 15.209	Table 4.1.2	ANSI C63.4	Enclosure	Mr. Y. Neuman, test engineer	August 19, September 5, 2001	**P**	
Radiated emission							
47CFR part 15, § 15.109	§ 4.1	ANSI C63.4	Enclosure	Mr. Y. Neuman, test engineer	August 19, 2001	**P**	

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

Test report approved by: Mr. M. Nikishin, EMC group leader

Mr. A. Usoskin, QA manager

[1] The rationale for not performing all the tests is either customer's request or EUT features, which define the applicability of tests. For EUT description – refer to paragraph 2.

[2] **P = Pass, F = Fail, NA = Not applicable, NT = Not tested**

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2 General information

2.1 Abbreviations and acronyms

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

AF	antenna factor
AG	amplifier gain
AVRG	average (detector)
CL	cable loss
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
m	meter
MHz	megahertz
NA	not applicable
QP	quasi-peak
RF	radio frequency
RE	radiated emission
s	second
V	volt
W	width

2.2 Specification references

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

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2.3 EUT description

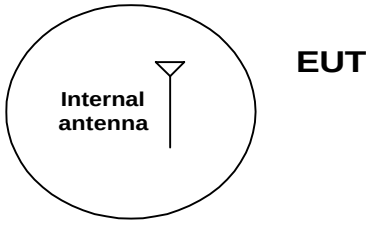
The EUT, TMW-L, is a water meter with a built-in 2-way RF communicator. The RF capabilities enable transmission of meter readings and some extra information to a collecting unit.
The TMW-L consists of three parts: RF transmitter and receiver, that operate in ISM band (923.6 MHz) and a microcontroller (plus a simple digital logic) which controls the operational modes.
The device is powered by two internal 3.6 V lithium batteries.

Receiver local oscillator frequency is 868.5 MHz.

2.4 EUT test configuration

The EUT test configuration is shown in Figure 2.4.1.

Figure 2.4.1 EUT test configuration



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3 Test facility description

3.1 Test facility description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private EMC, Safety and Telecommunication testing facility. Hermon Laboratories is listed by the Federal Communications Commission (USA) for all parts of Code of Federal Regulations 47 (CFR 47) and by Industry Canada for electromagnetic emissions (file numbers IC 2186-1 for OATS and IC 2186-2 for anechoic chamber), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-1082 for anechoic chamber, C-845 for conducted emissions site), assessed by 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 / EN 45001 for Electromagnetic Compatibility (commercial and military standards), 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.

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3.2 Statement of qualification

The test measurement data supplied in this test measurement report having been received by me, is hereby duly certified. The following is a statement of my qualifications.
I am an engineer, graduated from university in 1992 with an MScEE degree, have obtained 9 years experience in research and development of electronic devices.

I have been with Hermon Laboratories since January 2000.

Name: Mr. Yuri Neuman Signature: _____
Position: test engineer Date: October 16.2001

I hereby certify that this test measurement report was prepared by me and is hereby duly certified. The following is a statement of my qualifications.
I have a university degree and more than 10 years experience in document processing.
I have been with Hermon Laboratories since May 1999.

Name: Mrs. Valeria Mednikov Signature: _____
Position: certification engineer Date: October 16, 2001

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4 Emissions tests

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

4.1.1 General

This test was performed to measure field strength of emissions from EUT enclosure. The 3 m distance specification test limits are given in Table 4.1.1. The worst test results (lowest margin) were recorded in Table 4.1.2 and shown in associated plots.

Table 4.1.1 Field strength limits

	Frequency, MHz	Field strength of emission, dB(μV/m) @ 3 m distance	
		Average limit	Peak limit
carrier	923.6	94	114
harmonics		54	74

Emissions radiated outside of the specified frequency band, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Section 15.209, whichever is the lesser attenuation.

4.1.2 Test procedure

4.1.2.1 The test was performed in the anechoic chamber at 3 meters test distance, i.e. the distance between measuring antenna and EUT boundary. The EUT was set up as shown in Figure 4.1.1, associated photographs, energized and the performance check was conducted.

4.1.2.2 The EUT operated in continuous transmitting mode. The frequency range from 9 kHz up to 9.3 GHz (10^{th} harmonic) was investigated by means of loop active, biconilog and double ridged guide antennas.

4.1.2.3 To find maximum radiation the turntable was rotated 360^{o}, measuring antenna height was changed from 1 to 4 m, and the antennas polarization was changed from vertical to horizontal.

4.1.2.4 Spectrum analyzer settings are shown in Plots.

4.1.2.5 At frequencies above 5 GHz the field strength was calculated as follows:

$E = P_{SA} + 107$ dB + AF + CL – AG, where
P_{SA} – spectrum analyzer reading in dBm;
AF – antenna factor in dB(1/m);
CL – cable loss in dB;
AG – amplifier gain in dB.

4.1.2.6 Average factor –29.6 dB was calculated according to the formula:

Aver. factor = 20 log (T_{ON} / 100), where

T_{ON} , transmission duration within 100 ms, is 3.3 ms, refer to Plots 4.1.1 and 4.1.2.

20 log (3.3 ms/100 ms) = -29.6 dB.

4.1.2.7 Test results are shown in Plots 4.1.3 to 4.1.18.

4.1.2.8 The EUT has met the average emission requirements and peak emission limitations of §15.35 and successfully passed the test.

Reference numbers of test equipment used

HL 0041	HL 0412	HL 0446	HL 0465	HL 0521	HL 0554	HL 0589	HL 0604
HL 1200	HL 1424						

Full description is given in Appendix A.

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Table 4.1.2 Carrier and harmonic emission measurements

TEST SPECIFICATION: 47CFR part 15 subpart C § 15.249
DATE: August 15, 2001
RELATIVE HUMIDITY: 42%
AMBIENT TEMPERATURE: 24°C
THE EUT WAS TESTED AS: TABLE-TOP
DETECTOR USED: PEAK
FREQUENCY RANGE: 900 MHz – 9.3 GHz

a) Peak limit

Frequency, MHz	Ant. type	Radiated emission, peak, dB (µV/m)	Peak limit @ 3 m, dB(µV/m)	Margin, dB	Pass/ Fail
923.43	BL	106.74	114	7.26	Pass
1737.538	DR	44.16	74	29.84	Pass
1846.875	DR	48.43	74	25.57	Pass
2606.175	DR	52.32	74	21.68	Pass
2770.40	DR	52.55	74	21.45	Pass
3475.0	DR	50.42	74	23.58	Pass

Table calculations and abbreviations:
Ant. type = antenna type (BL – biconilog, DR – double ridged guide antenna).
Peak limit = average limit dB(µV/m) +20 dB.
Margin = dB below (negative if above) limit.

b) Average limit

Frequency, MHz	Ant. type	Radiated emission, dB (µV/m)	Average limit @ 3 m, dB(µV/m)	Margin, dB	Pass/ Fail
923.43	BL	77.14	94	16.86	Pass
1737.538	DR	14.56	54	39.44	Pass
1846.875	DR	29.6	54	24.4	Pass
2606.175	DR	22.72	54	31.28	Pass
2770.40	DR	22.95	54	31.05	Pass
3475.0	DR	20.82	54	33.18	Pass

Table calculations and abbreviations:
Radiated emission dB(µV/m) = peak measured result (dB(µV)) + average factor (dB).
Average factor = -29.6 dB.
Average limit is in accordance with § 15.249 (a).
Margin = dB below (negative if above) limit.
Ant. type = antenna type (BL – biconilog, DR – double ridged guide antenna).

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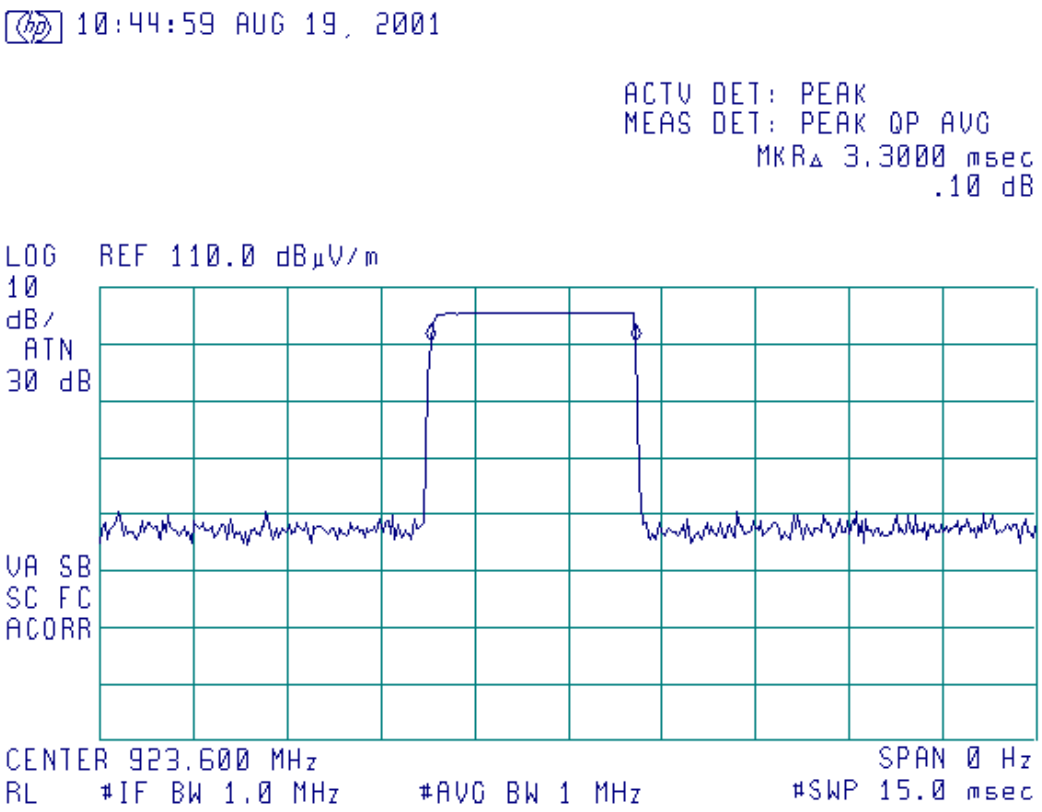
Plot 4.1.1 Duty cycle measurements



Duty cycle = 3.3 ms / 100 ms = 3.3%

Average factor = 20*log(0.033) = -29.6 dB

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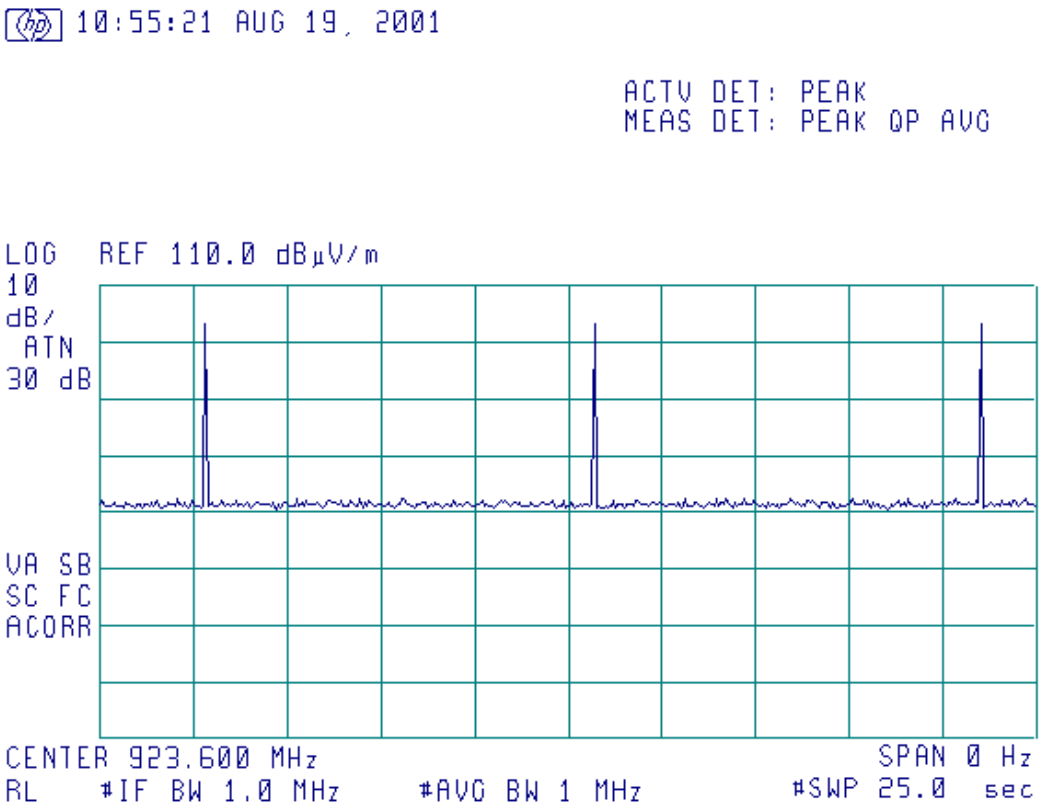
Plot 4.1.2 Duty cycle measurements



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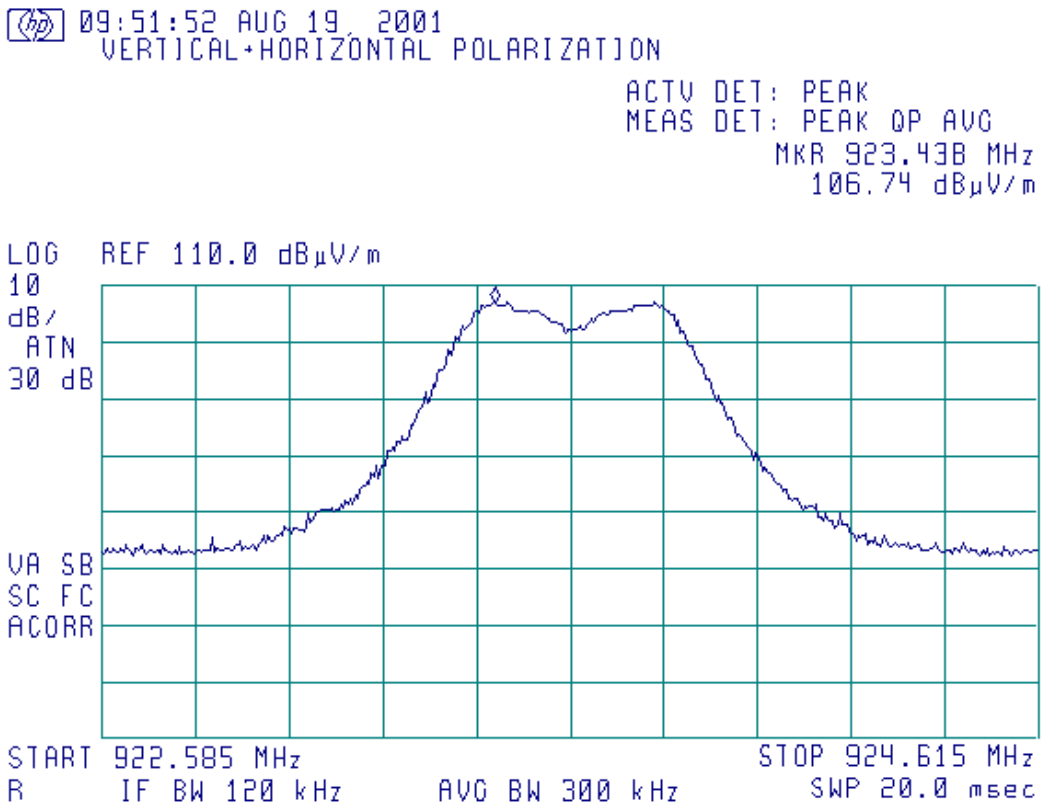
Plot 4.1.3 Field strength of fundamental



E_{avg} = E_{peak} + Average factor = 106.74 – 29.6 = 77.14 dB(µV/m)

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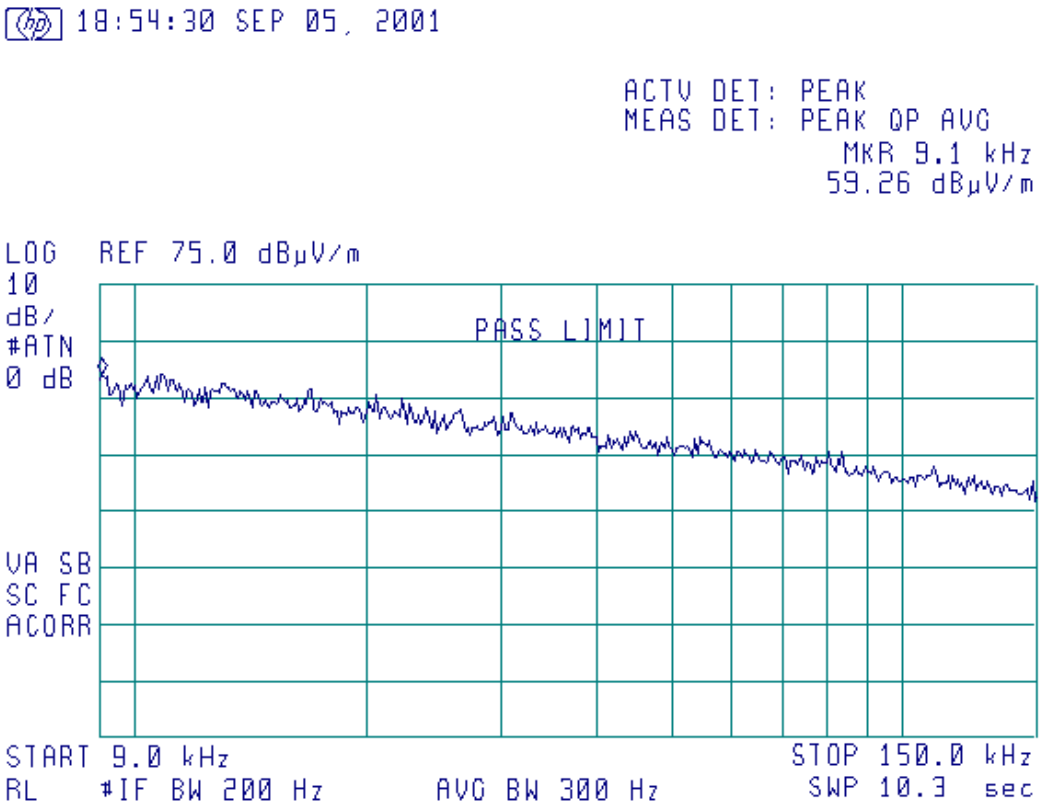
Plot 4.1.4 Out of band spurious emissions,
9 kHz – 150 kHz frequency range



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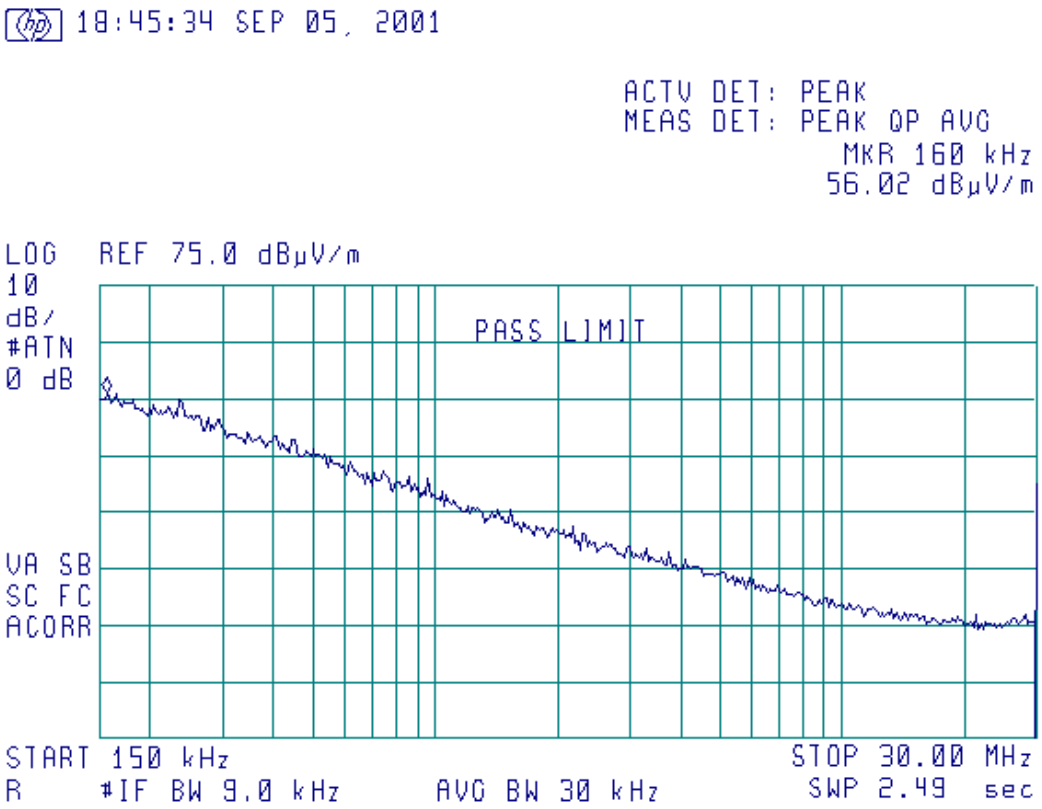
Plot 4.1.5 Out of band spurious emissions,
150 kHz – 30 MHz frequency range



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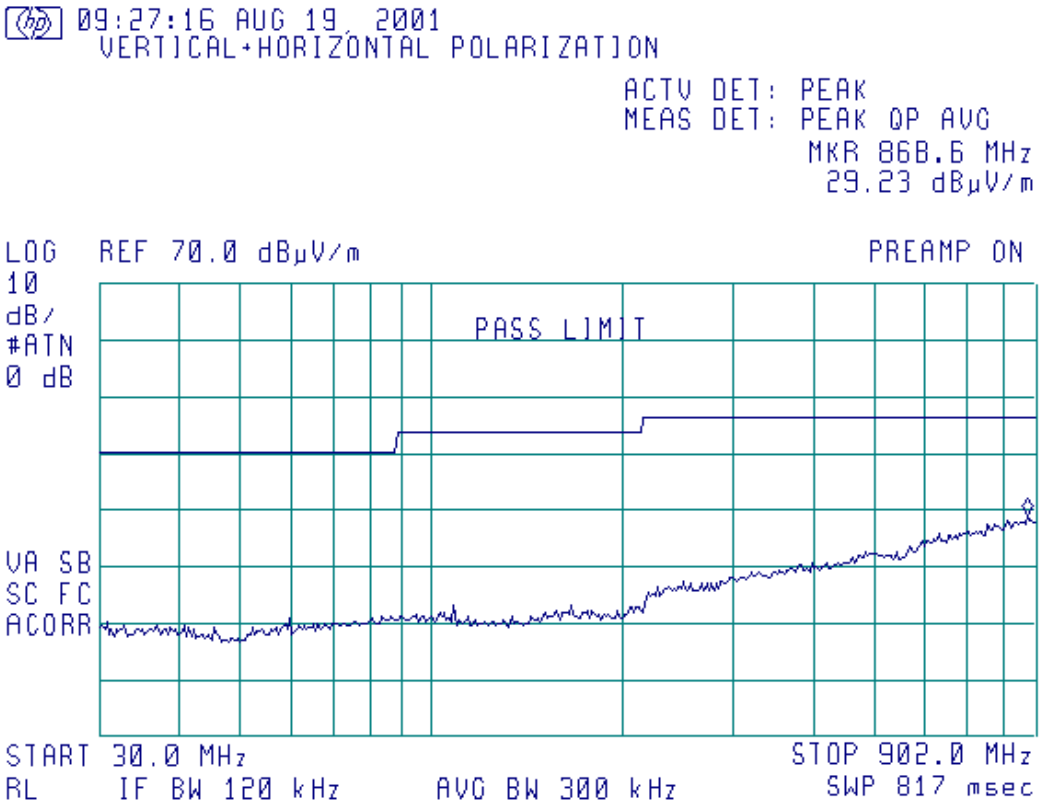
Plot 4.1.6 Out of band spurious emissions,
30 MHz – 902 MHz frequency range



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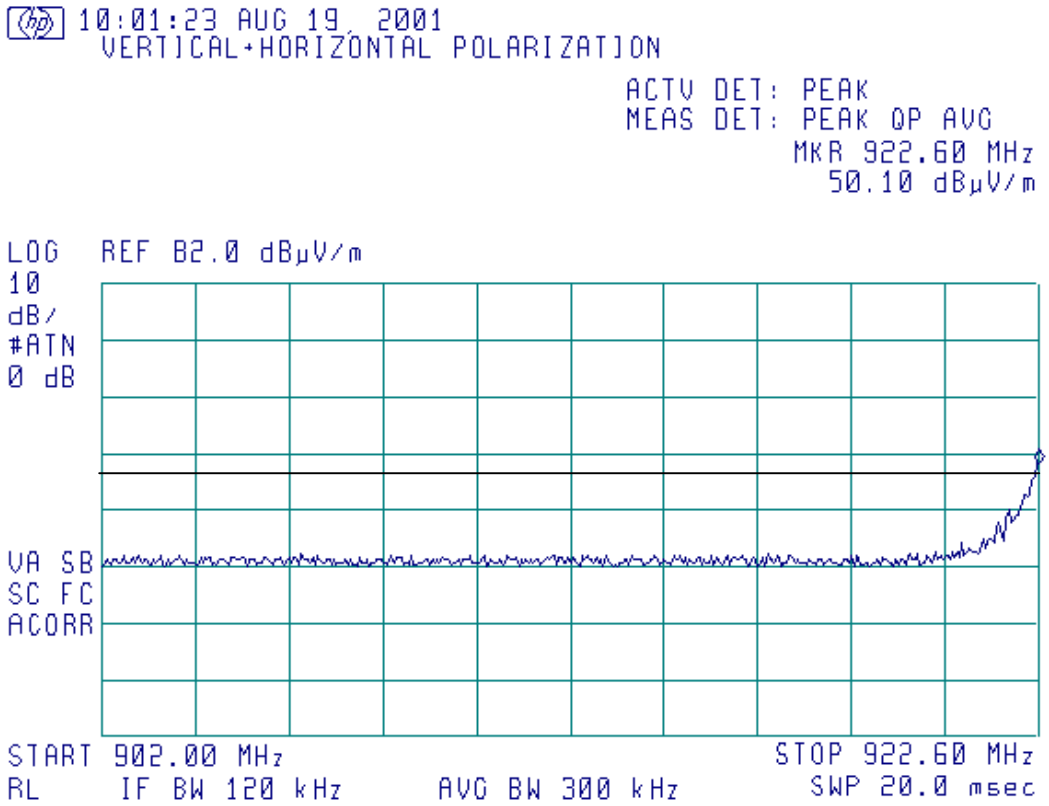
Plot 4.1.7 Field strength at band edges



All emissions are more than 50 dB below the level of fundamental.
Only the Tx signal exceeds the 15.109 specification limit.

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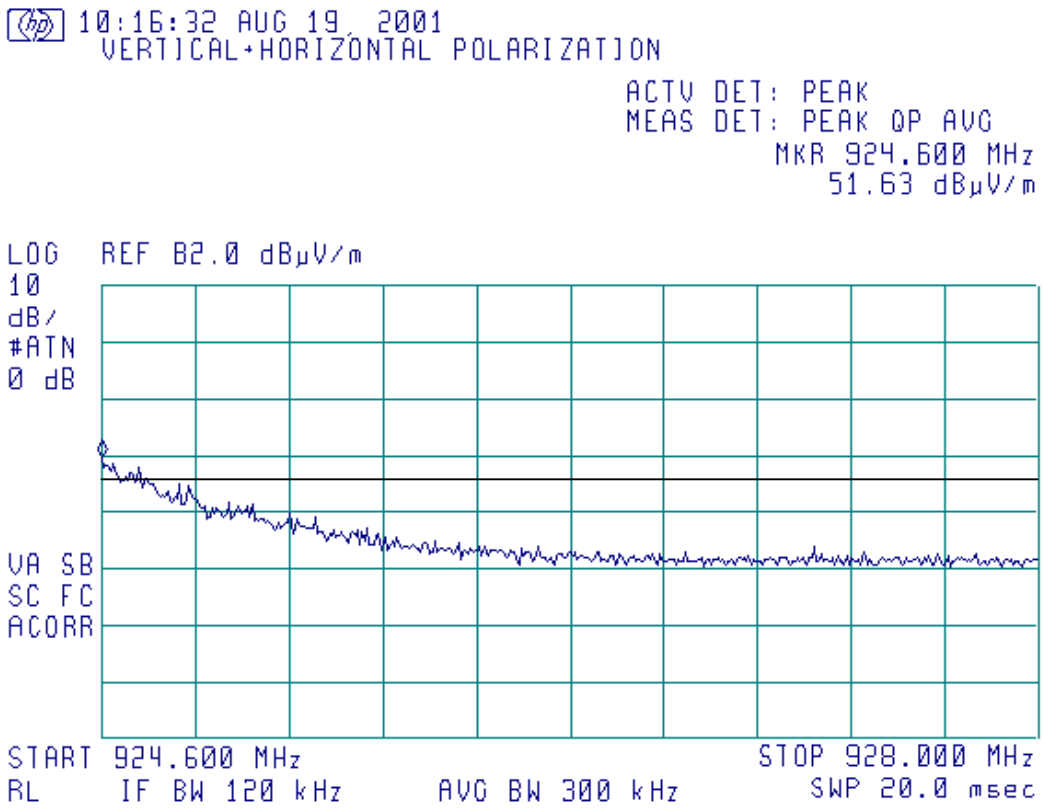
Plot 4.1.8 Field strength at band edges



All emissions are more than 50 dB below the level of fundamental.
Only the Tx signal exceeds the 15.109 specification limit.

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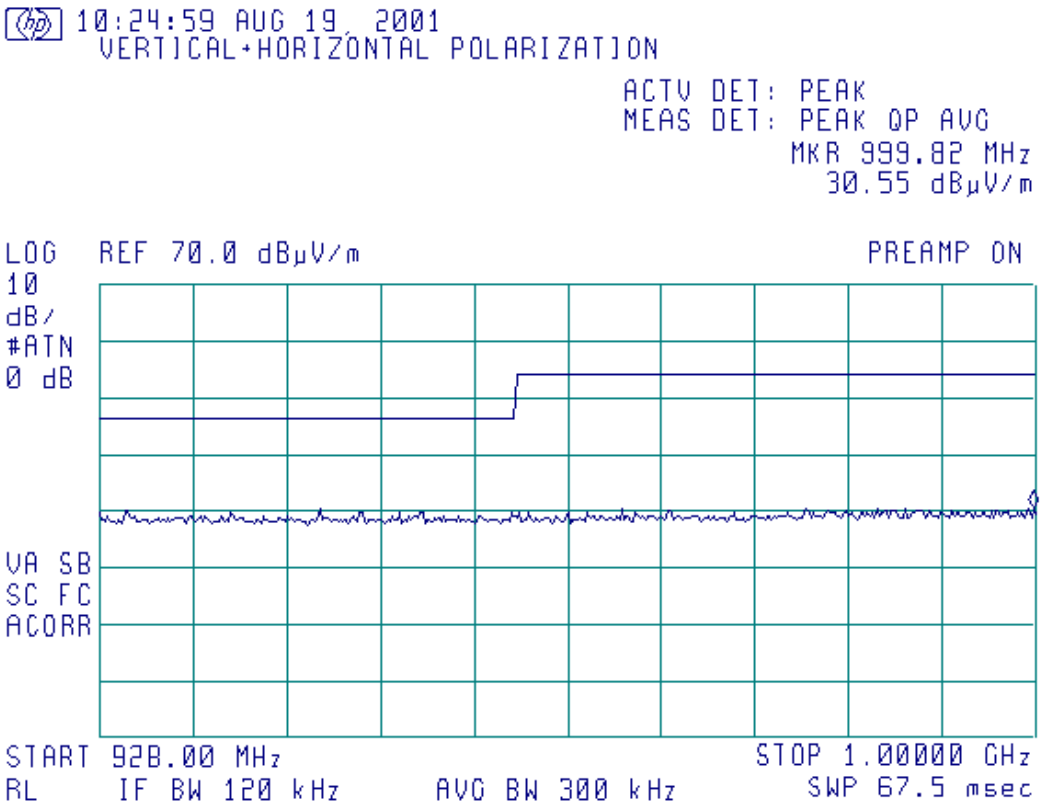
Plot 4.1.9 Out of band spurious emissions,
928 MHz – 1 GHz frequency range



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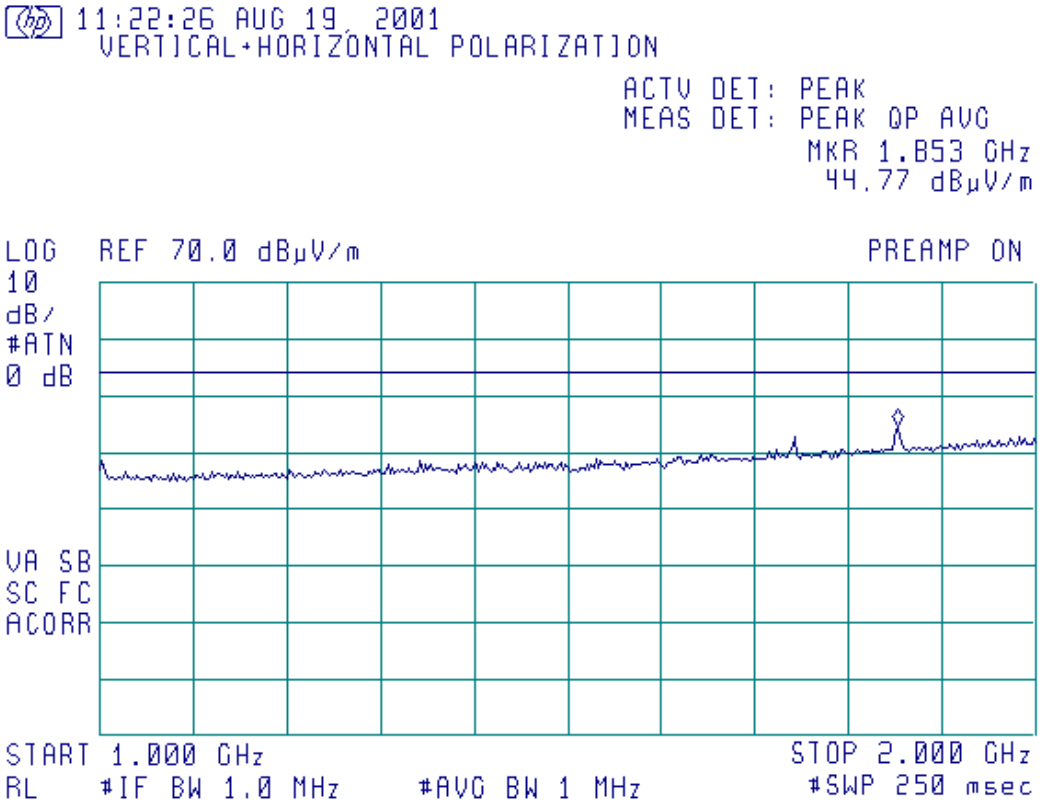
Plot 4.1.10 Radiated emissions,
1 GHz – 2 GHz frequency range



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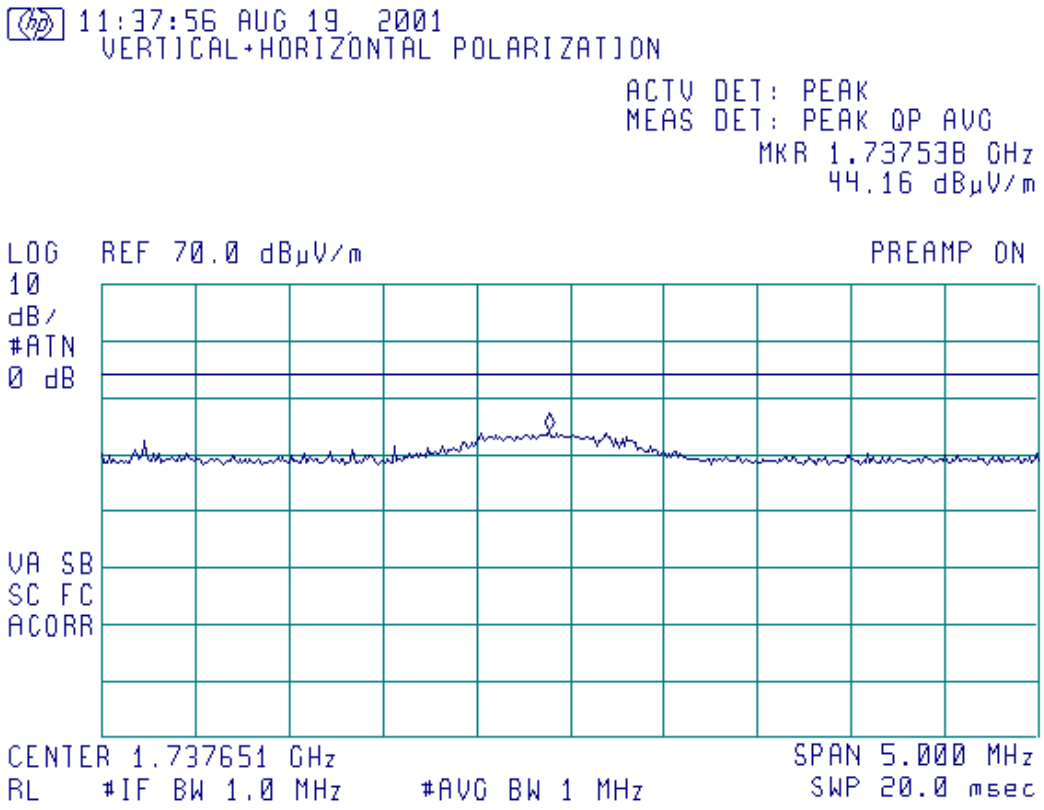
**Plot 4.1.11 Field strength,
second harmonic of LO**



E_{avg} = E_{peak} + Average factor = 44.16 – 29.6 = 14.56 dB(µV/m)

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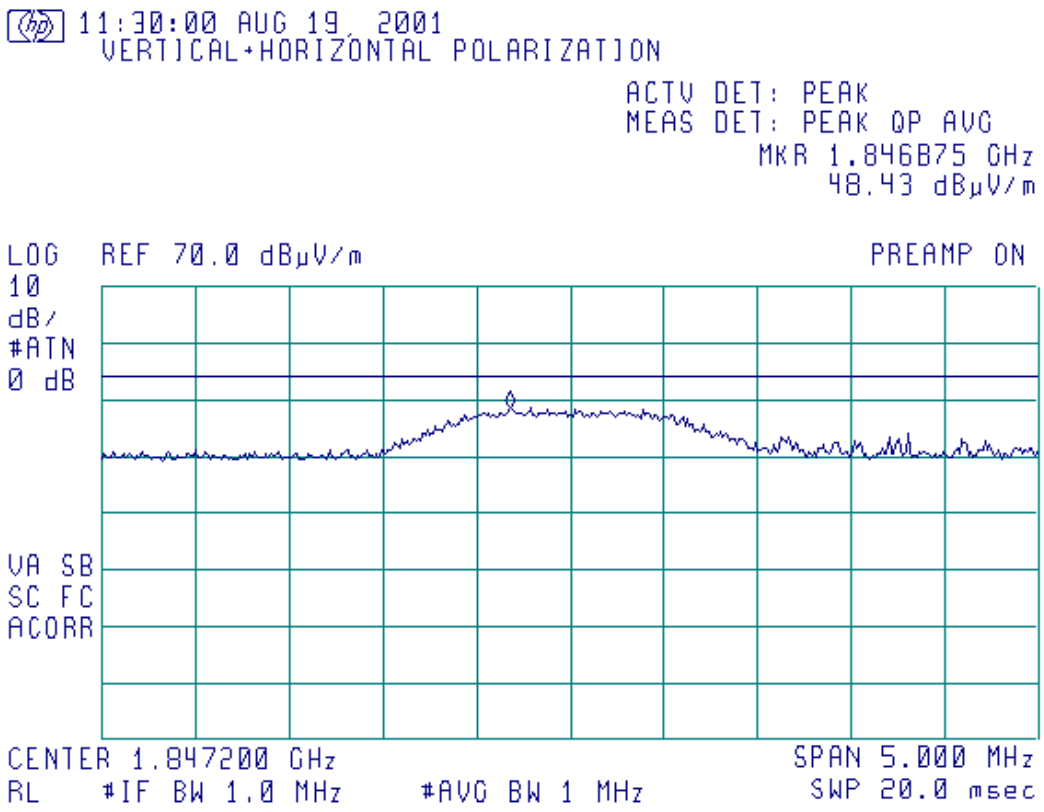
**Plot 4.1.12 Field strength,
second harmonic of fundamental**



E_{avg} = E_{peak} + Average factor = 48.43 – 29.6 = 18.83 dB(µV/m)

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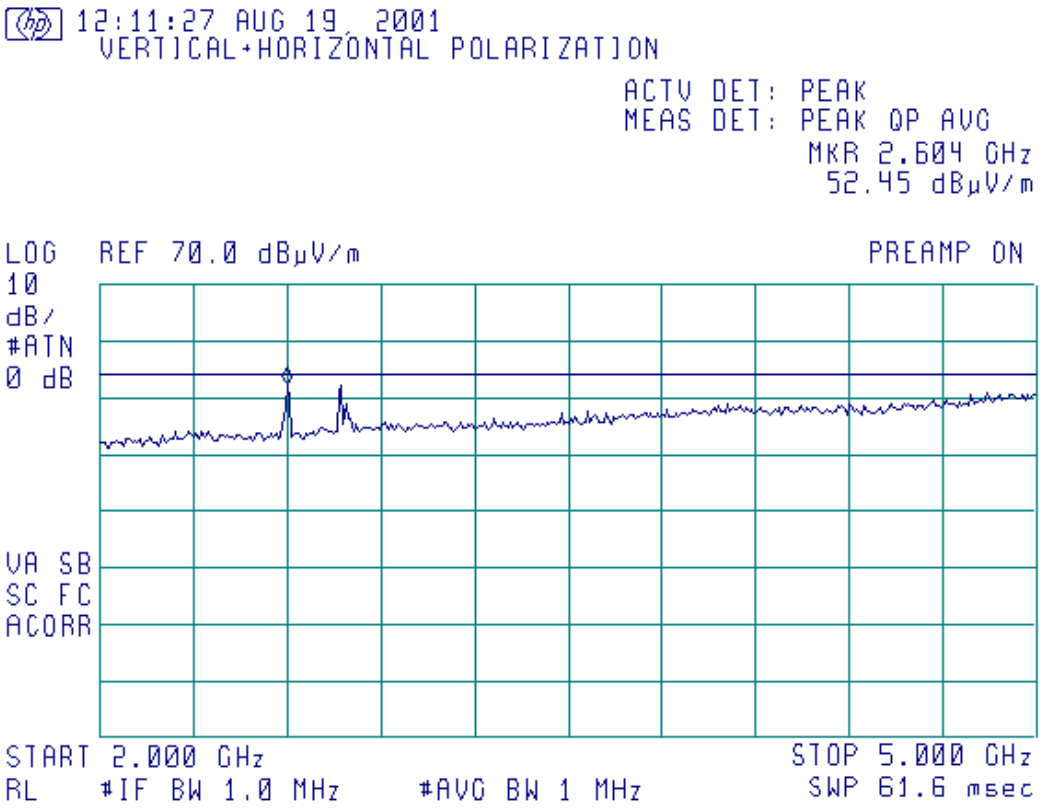
Plot 4.1.13 Radiated emissions,
2 GHz – 5 GHz frequency range



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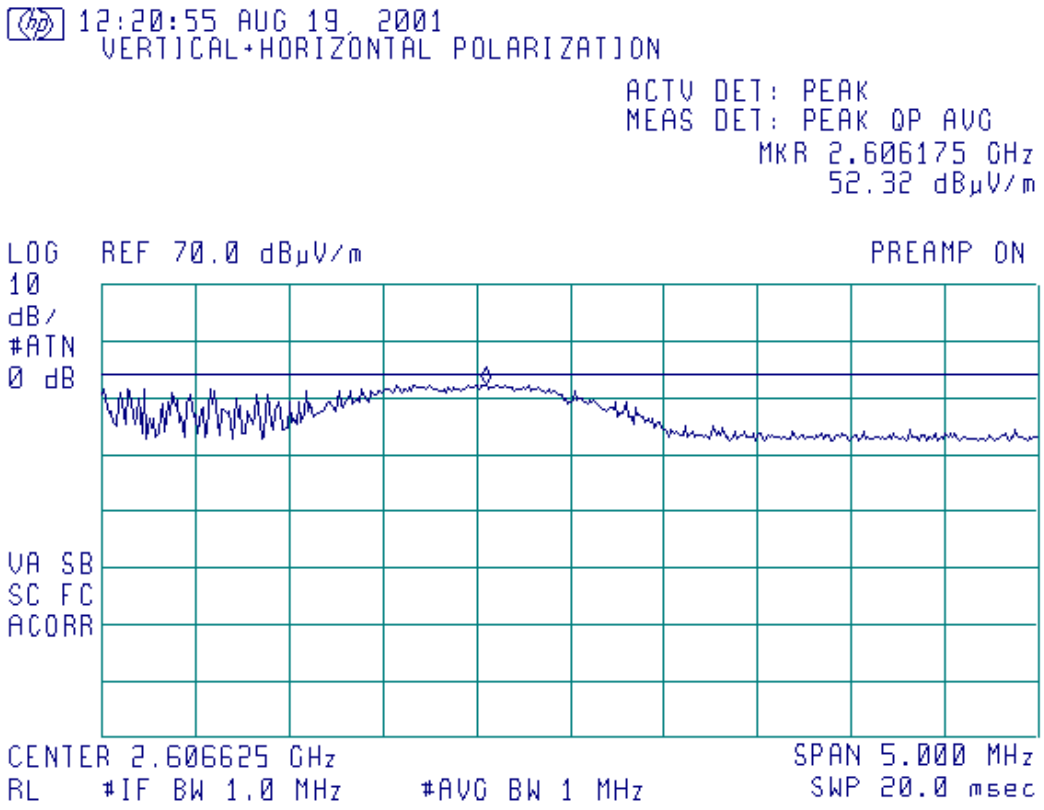
**Plot 4.1.14 Field strength,
third harmonic of LO**



E_{avg} = E_{peak} + Average factor = 52.32 – 29.6 = 22.72 dB(µV/m)

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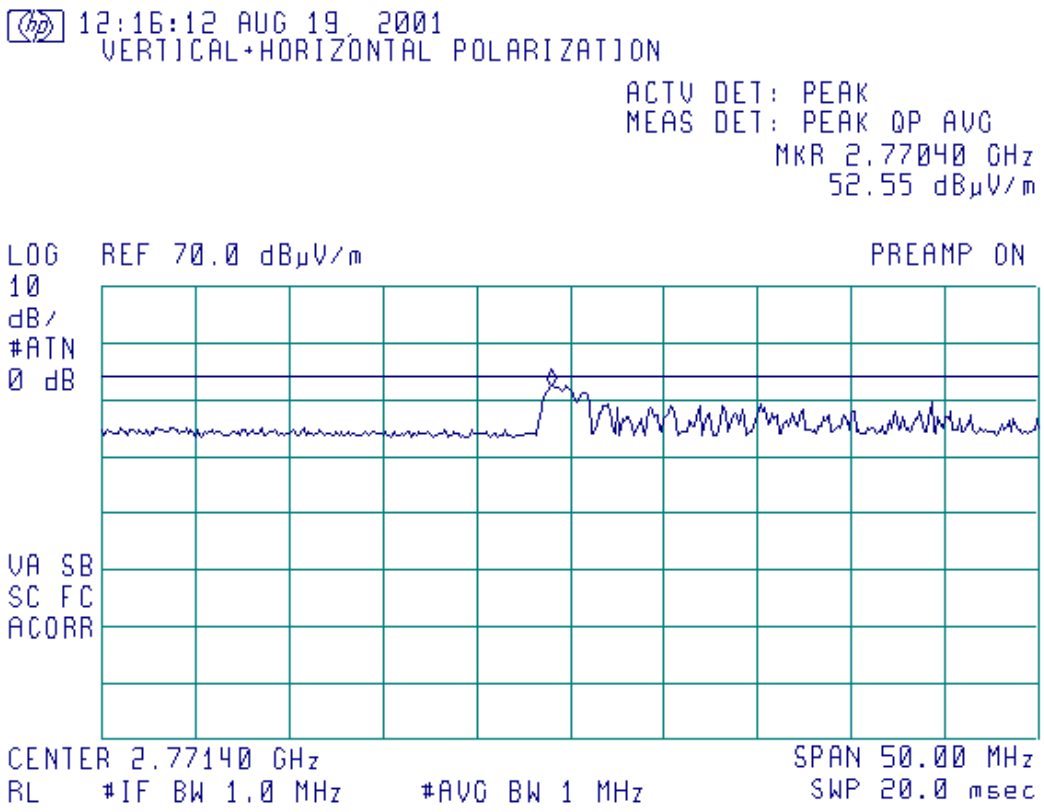
**Plot 4.1.15 Field strength,
third harmonic of fundamental**



E_{avg} = E_{peak} + Average factor = 52.55 – 29.6 = 22.95 dB(µV/m)

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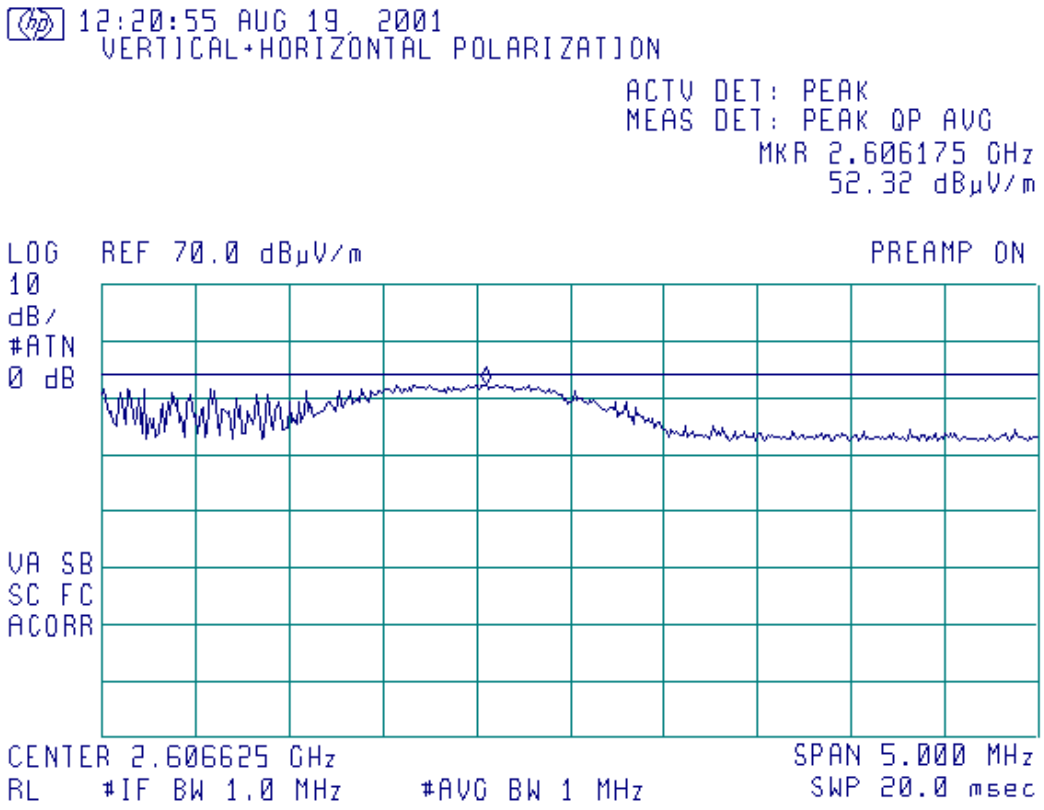
**Plot 4.1.16 Field strength,
fourth harmonic of LO**



E_{avg} = E_{peak} + Average factor = 50.42 – 29.6 = 20.82 dB(µV/m)

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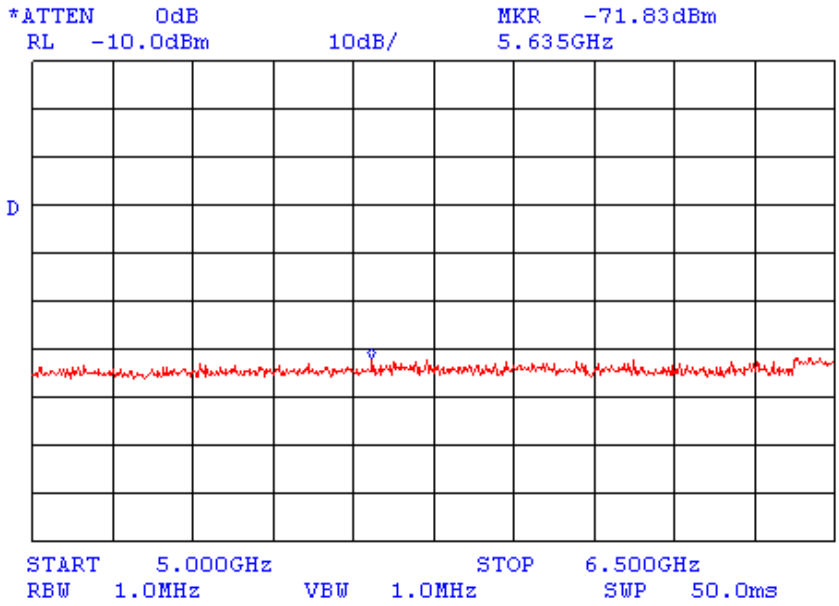
Plot 4.1.17 Radiated emissions,
5 GHz – 6.5 GHz frequency range



No spurious emissions found

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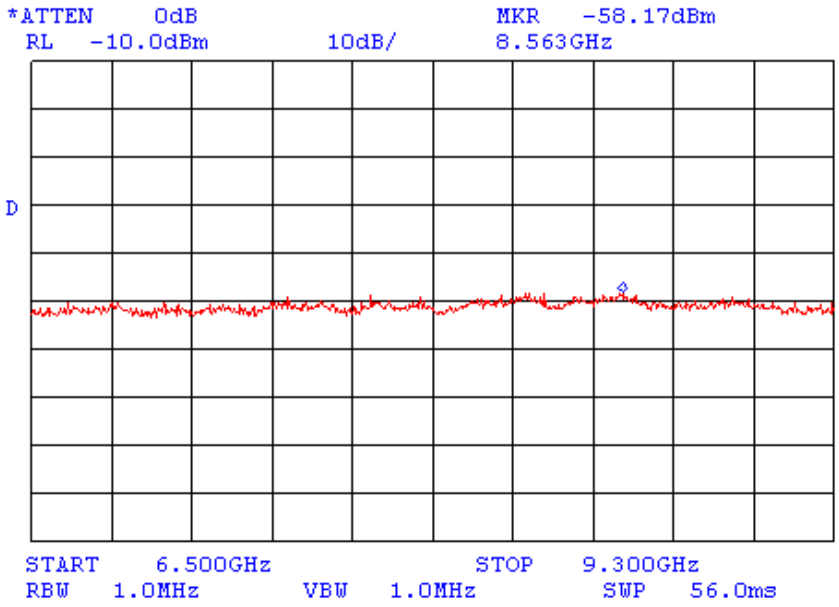
Plot 4.1.18 Radiated emissions,
6.5 GHz – 9.3 GHz frequency range



No spurious emissions found

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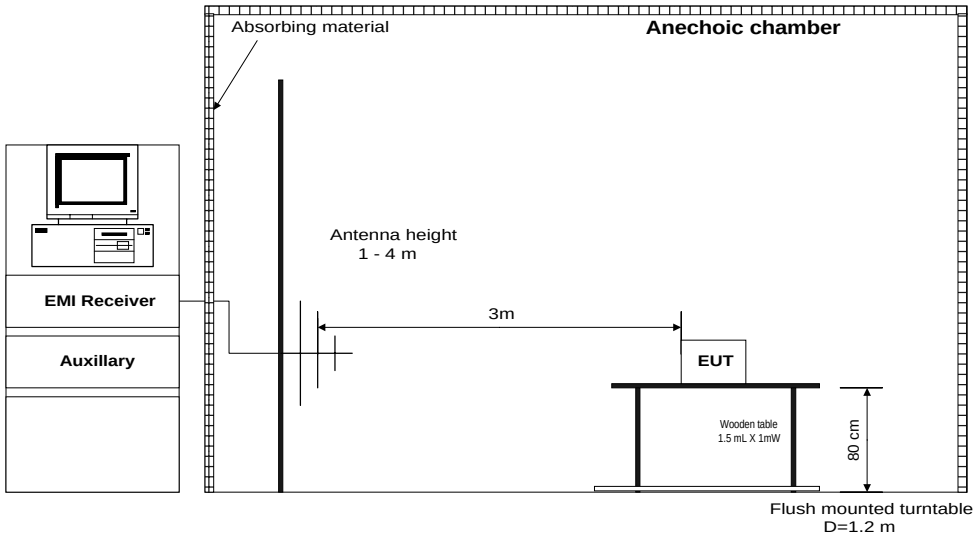
Figure 4.1.1 Setup for radiated emissions test, anechoic chamber method



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Photograph 4.1.1 Radiated emission measurements test setup, frequency range 1 GHz – 9.3 GHz

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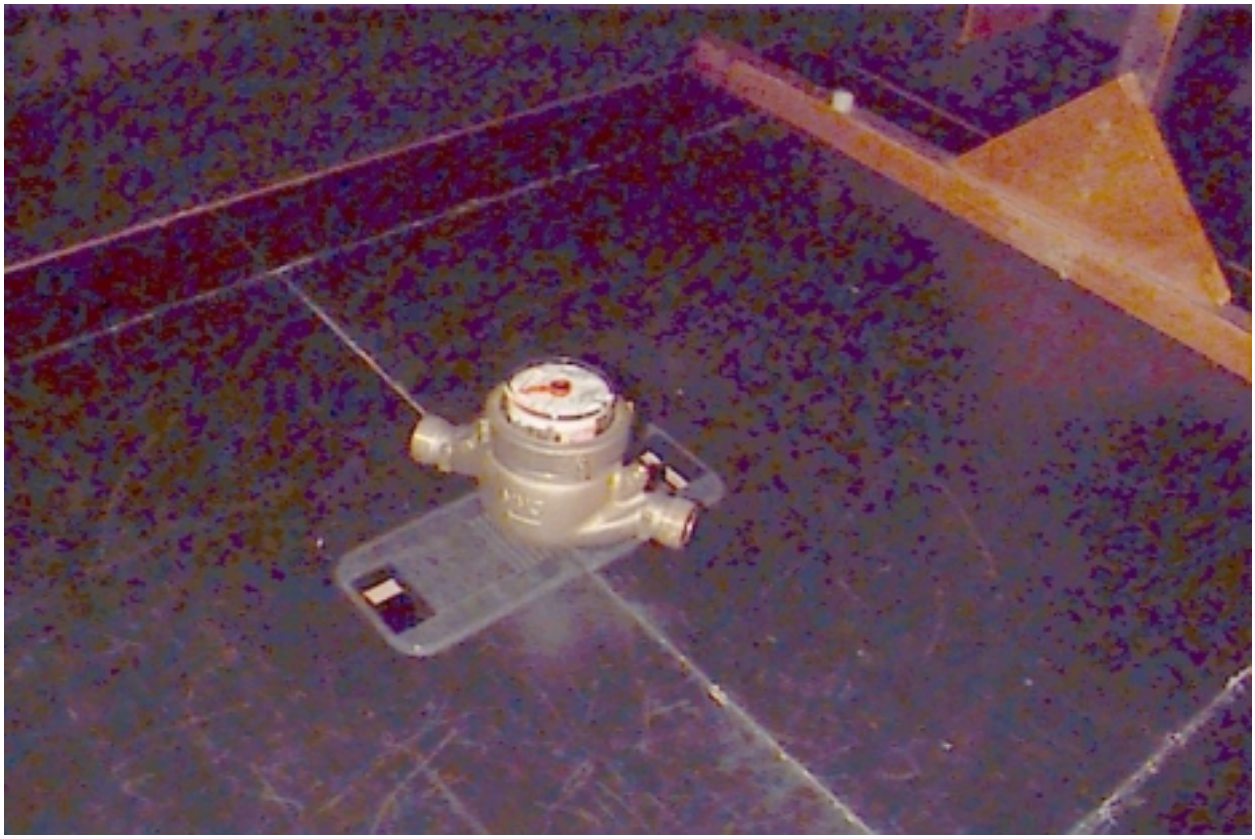
Photograph 4.1.2 Radiated emission measurements test setup, frequency range 1 GHz – 9.3 GHz



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4.2 Radiated emission measurements according to §15.109

4.2.1 General

In frequency range 30 MHz – 5 GHz more stringent limit for digital part, excluding carrier and harmonics, was used, refer to Table 4.2.1.

TEST SPECIFICATION: 47CFR part 15, sub. B and C, Class B

Table 4.2.1 Limits for electric field strength, quasi-peak detector

Frequency, MHz	Class B equipment, dB(μV/m) @ 3m distance
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
960 – 5000	54.0

4.2.2 Test procedure

4.2.2.1 The test was performed in the anechoic chamber at 3 meter test distance. The EUT was set up as shown in Figure 4.1.1, energized and the performance check was conducted.

4.2.2.2 The EUT operated in continuous transmitting mode. The frequency range from 30 MHz to 5 GHz was investigated by means of biconilog and double ridge guide antennas connected to EMI receiver.

4.2.2.3 To find maximum radiation the turntable was rotated 360^{o}, measuring antenna height was changed from 1 to 4 m, and the antennas polarization was changed from vertical to horizontal.

4.2.2.4 Test results are shown in Plots 4.1.6 to 4.1.10, 4.1.13.

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

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

The test equipment has been calibrated according to its recommended procedures and is within the manufacturer's published limit of error. The standards and instruments used in the calibration system conform to the present requirements of MIL-STD-45662A.
The laboratory calibrates its standards by a third party (traceable to NIST, USA) on a regular basis according to equipment manufacturer requirements. Hermon Labs EMC measurements uncertainty is given in the table below.

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Radiated emissions in the anechoic chamber at 3 m measuring distance	▪ Biconilog antenna: ±3.2 dB ▪ Double ridged guide antenna: ± 2.36 dB

Test equipment and ancillaries used for tests

HL Serial No.	Description	Manufacturer information			Due Calibr.
		Name	Model No.	Serial No.	
0041	Double ridged guide antenna, 1-18 GHz	Electro-Metrics	RGA 50/60	2811	8/02
0412	Cable, Coax, Microwave, DC-18 GHz, N-N, 3 m	Gore	36Q01Q01118.2		9/02
0446	Active Loop Antenna, 10 kHz-30 MHz	Electro-Mechanics	6502	2857	11/01
0465	Anechoic Chamber 9 (L) x 6.5 (W) x 5.5 (H) m	Hermon Labs	AC-1	023	3/02
0521	Spectrum Analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz)	Hewlett Packard	8546A	0319	7/02
0554	Amplifier, 2 – 18 GHz RF	Miteq	AFD-4	4300	12/01
0589	Cable Coaxial, GORE A2POL118.2, 3m	Hermon Labs	GORE-3	589	11/01
0604	Antenna Biconilog Log-Periodic/ T Bow-Tie, 26 - 2000 MHz	EMCO	3141	9611-1011	12/01
1200	Quadruplexer	Elettronica	UE 84	0240	2/02
1424	Spectrum analyzer	Agilent Technologies	8564EC	3946A00219	9/02