HERMON LABORATORIES

ELECTROMAGNETIC EMISSIONS TEST REPORT

according to FCC Part 15 subpart C, §15.247 and subpart B

for

INNOWAVE ECI TELECOM LTD.

EQUIPMENT UNDER TEST:

Radio Port & Coupler

RPC 2.4 GHz

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ACCREDITED
839.01
Electrical

Description of equipment under test

Test items	Radio port & coupler
Manufacturer	Innowave ECI Telecom Ltd.
Types (Models)	**RPC 2.4 GHz**
Receipt date	January 25, 2000

Applicant information

Applicant's representative	Mr. Robert Levy
Applicant's responsible person	Mr. Amnon Beer, engineering manager
Company	Innowave ECI Telecom Ltd.
Address	4 Hashiloach Street
Postal code	49104
City	Petach-Tikva
Country	Israel
Telephone number	+972 3 9263507
Telefax number	+972 3 9263652

Test performance

Project Number:	13901
Location	Hermon Laboratories
Test performed	July 1996, January 25-27, 2000
Purpose of test	The EUT certification in accordance with CFR 47 part 2, §2.1033
Test specification(s)	FCC Part 15, Subpart C, §15.247, §§15.205, 15.209, 15.109

Table of Contents

1 Summary and signatures

The EUT, Radio port & coupler RPC 2.4 GHz, was tested according to FCC part 15 subpart C, §.15.247 and part 15 subpart B §.15.109 and found to comply with the standard requirements.

Test performed by:

Mrs. E. Pitt, test engineer _____

Test report prepared by:

Mrs. V. Mednikov, certification engineer _____

Test report approved by:

Mr. M. Nikishin, EMC group leader _____

Mr. A. Usoskin, QA manager _____

The A2LA logo endorsement applies only to the test methods and the standards that are listed in the scope of Hermon Laboratories accreditation by A2LA.
Through this report period is used as decimal separator while thousands are separated by comma.
This report is in conformity with EN 45001 and ISO GUIDE 25.
The test results relate only to the items tested.

2 General information

2.1 Abbreviations and acronyms

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

AC	alternating current
AVRG	average (detector)
BER	bit error rate
BW	bandwidth
CE	conducted emissions
cm	centimeter
CW	sine wave
dB	decibel
dBm	decibel referred to one milliwatt
dB(μA)	decibel referred to one microampere
dB(μV)	decibel referred to one microvolt
dB(μV/m)	decibel referred to one microvolt per meter
DC	direct current
EMC	electromagnetic compatibility
EUT	equipment under test
FSK	frequency shift keying
GHz	gigahertz
H	height
HL	Hermon Laboratories
Hz	hertz
IF	Intermediate frequency
kHz	kilohertz
L	length
LISN	line impedance stabilization network
m	meter
mm	millimeter
MHz	megahertz
msec	millisecond
NA	not applicable
NARTE	National Association of Radio and Telecommunications Engineers, Inc.
nF	nanofarad
Ω	ohm
QP	quasi-peak (detector)
PC	personal computer
RBW	resolution bandwidth
RF	radio frequency
RE	radiated emission
sec	second
UTP	unshielded twisted pair
V	volt
V/m	volt per meter
W	watt

2.2 Specification references

CFR 47 part 15:1998	Radio Frequency Devices.
ANSI C63.2:1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications.
ANSI C63.4:1992	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.

2.3 EUT description

The EUT, Radio port coupler (RPC) operates as a base station which incorporates an internal antenna and provides a connection to a sectorial external antenna or another RPC.

Upon connection to the radio port control unit (RPCU) via two DSL lines radio port coupler enters a radio ready state and transmits (air link) to the FAU unit. The RPC-2.4 is FHSS modulated and operates at 2.4 GHz frequency.

The modules of the RPC contain several frequency generation circuits.

The PLI module contains crystal of 15.36MHz.

The RF Module (namely the PC module) contains the following crystals: 14MHz, 56.238MHz.

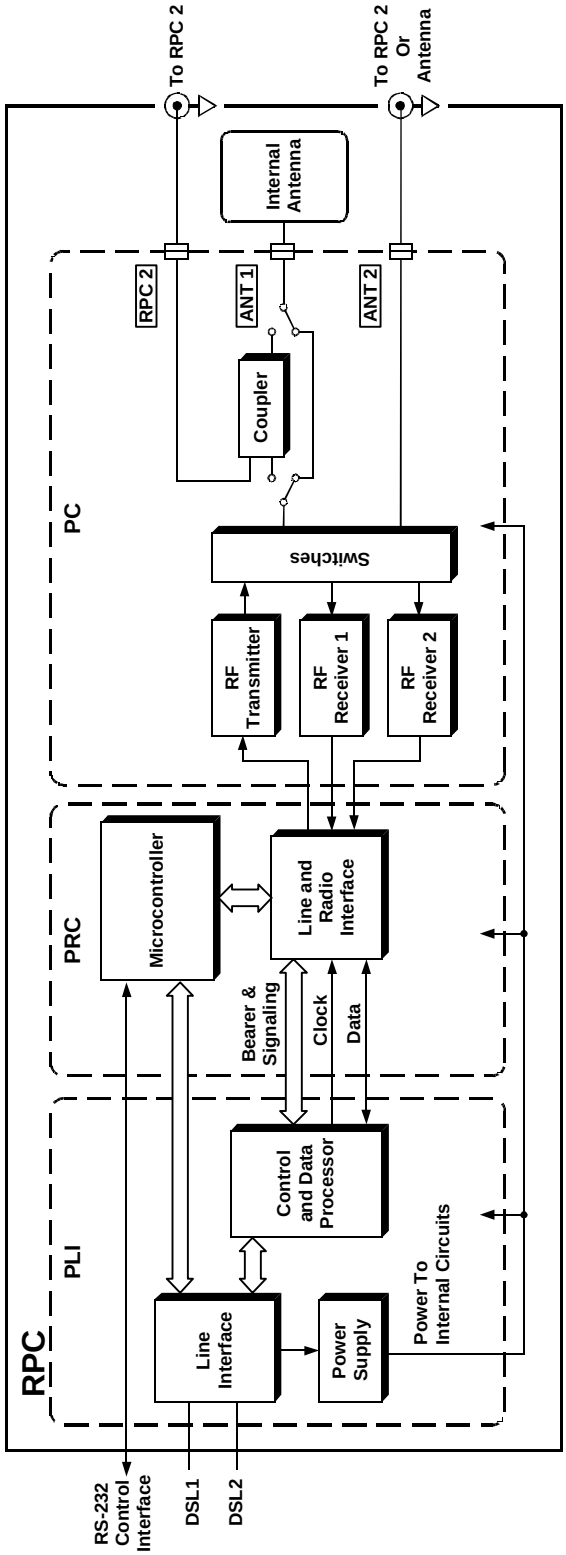
The PRC module contains crystal of 24MHz.

The RPC operates at pseudorandomly hopping frequencies scenario. Upon installation, desired frequencies are loaded to the frequency table in the radio digital memory. Number of frequencies is any combination of more than 75 frequencies in the range of 2400 MHz to 2480MHz. The system assigns a pseudorandomly frequencies order for the radio hops. The order of hops is kept the same all the time after installation.

The functional block-diagram is given in Figure 2.3.1.

The EUT is powered via DSL lines from RPCU, 180 V DC. The RPCU is powered by 48 V DC power supply.

Figure 2.3.1 RPC functional block-diagram



2.4 EUT test configuration

The EUT test configuration is given in Figure 2.4.1, ports and lines description in Table 2.4.1, EUT support/test description in Table 2.4.2.

Table 2.4.1
EUT ports and lines

Port type	Port Description	Quantity	Cable type description	Cable length, m	Connected to
Communication	DSL	2	UTP 2 X 2	3	RPCU
Signal	antenna	1	coax	1	antenna or other RPC

Table 2.4.2
EUT support/test equipment

Description	Model number	Serial number
RPCU	RPCU	86380920000
PC Compaq*	LTE5000	61041

* - was used to activate radio mode

Figure 2.4.1
EUT conducted emission test configuration

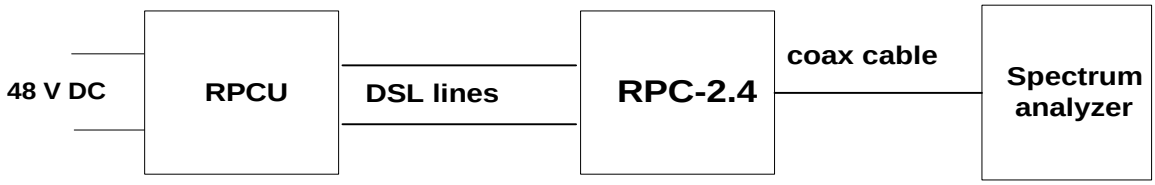
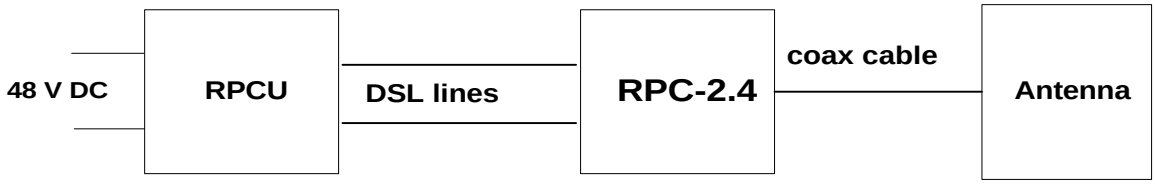


Figure 2.4.2
EUT radiated emission test configuration



3 Test Facility Description

3.1 General

Tests were performed at Hermon Laboratories, 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), listed by Industry Canada for radiated measurements (file numbers IC 2186-1 for OATS and IC 2186-2 for anechoic chamber), recognized by VDE (Germany) for witness test, certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-809 for anechoic chamber, C-845 for conducted emissions site), assessed by NMi Certin B.V. (Netherlands) for a number of EMC, Telecommunications and Safety standards, recognized by TUV Sudwest (Germany) for Safety testing, and Accredited by AMTAC (UK) for safety of Medical Devices. The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO GUIDE 25/EN 45001 for EMC, Telecommunications and Product Safety Information Technology Equipment (Certificate No. 839.01). At the end of 1999, Hermon Laboratories signed an agreement with Intertek Testing Services NA. INC. concerning mutual recognition of the test results for EMC and Safety. According to this agreement Hermon Laboratories customers can bear ETL safety mark after successful testing in Hermon Laboratories. Also the laboratory performs various follow-up services.

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

3.2 Equipment calibration

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 standards are calibrated by the third party (traceable to NIST, USA) on a regular basis according to equipment manufacturer requirements.

3.2.1 Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Radiated emissions in the open field test site at 10 m measuring distance	Biconilog antenna: ±3.2 dB Log periodic antenna: ±3 dB Biconical antenna: ±4 dB
Radiated emissions in the anechoic chamber at 3 m measuring distance	Biconilog antenna: ±3.2 dB

3.3 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 the University in 1974 with an MScEE degree, have obtained 26 years experience in EMC measurements and have been with Hermon Laboratories since 1991. Also, I am an EMC accredited test laboratory engineer certified by the National Association of Radio and Telecommunications Engineers, Inc. (USA.), the certificate no. is ATL-0006-E.

Name: Mrs. Eleonora Pitt Signature: _____
Position: test engineer Date: March 6, 2000

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: March 6, 2000

4 Emission measurements

4.1 Frequency hopping channels separation and hopping frequency usage test according to §15.247(a)(1)(ii)

4.1.1 General

This test was performed to prove that the EUT frequency hopping system uses at least 75 hopping frequencies and has hopping channel carrier frequencies separation by a minimum of 25 kHz or by the 20 dB bandwidth of the hopping channel, whichever is greater.

4.1.2 Test procedure

The EUT was connected to the computer via RS232 and radio ready mode was activated. The EUT output was connected to the spectrum analyzer via 30 dB attenuator. For test configuration refer to Figure 2.4.1.

All spectrum analyzer settings are shown in Plots.

The Plots 4.1.1 to 4.1.9 show the EUT occupied frequency band 2.401 to 2.480 MHz. 79 channels from 2.401 to 2.479 MHz are present which is greater than required 75 channels. The delta markers on each plot show the adjacent channel separation which is around 1 MHz, much higher than 25 kHz minimum requirements and greater than 20 dB occupied bandwidth which us less than 1 MHz. The EUT successfully passed this test.

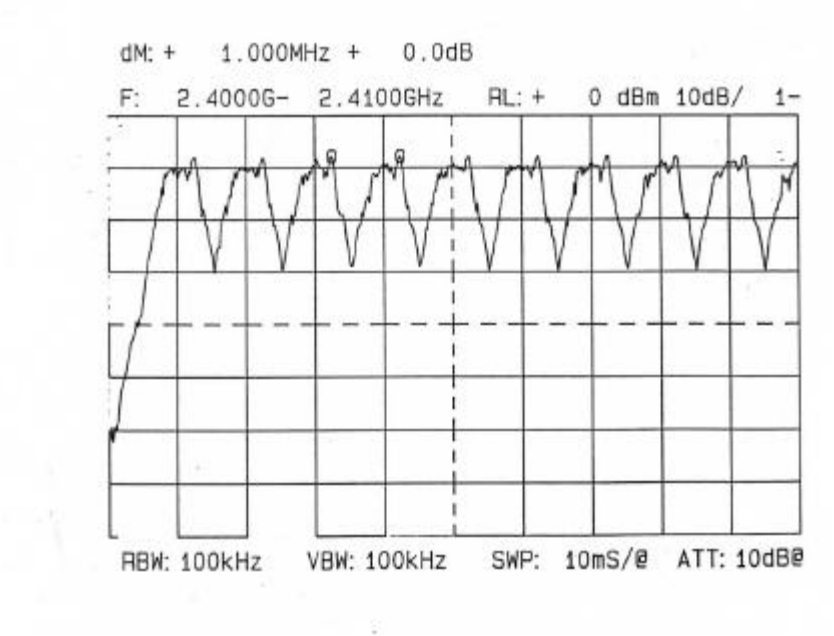
Reference numbers of test equipment used

HL 0025	HL 0056	HL 0872

Full description is given in Appendix A.

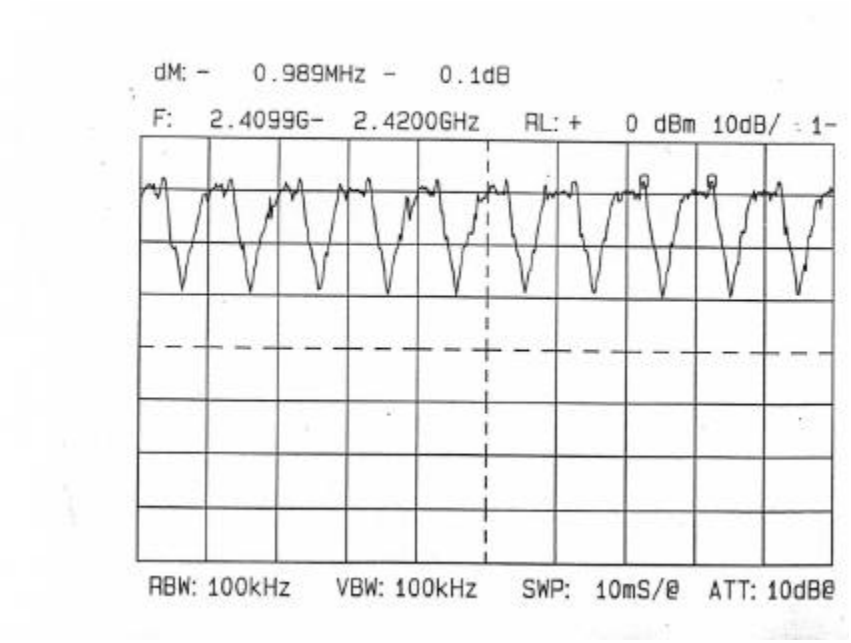
Plot 4.1.1

Test specification: § 15.247(a)(1)(ii)
Hopping channels separation test results



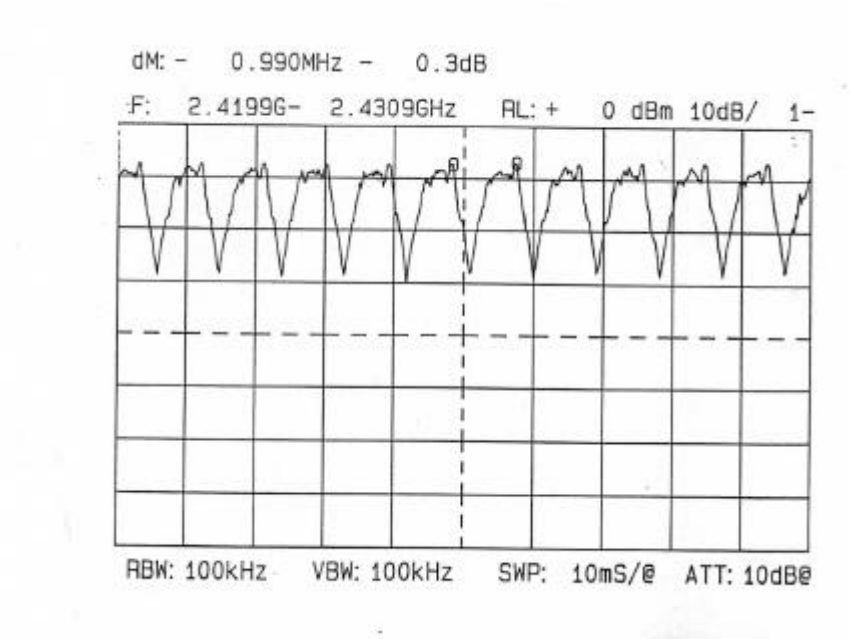
Plot 4.1.2

Test specification: § 15.247(a)(1)(ii)
Hopping channels separation test results



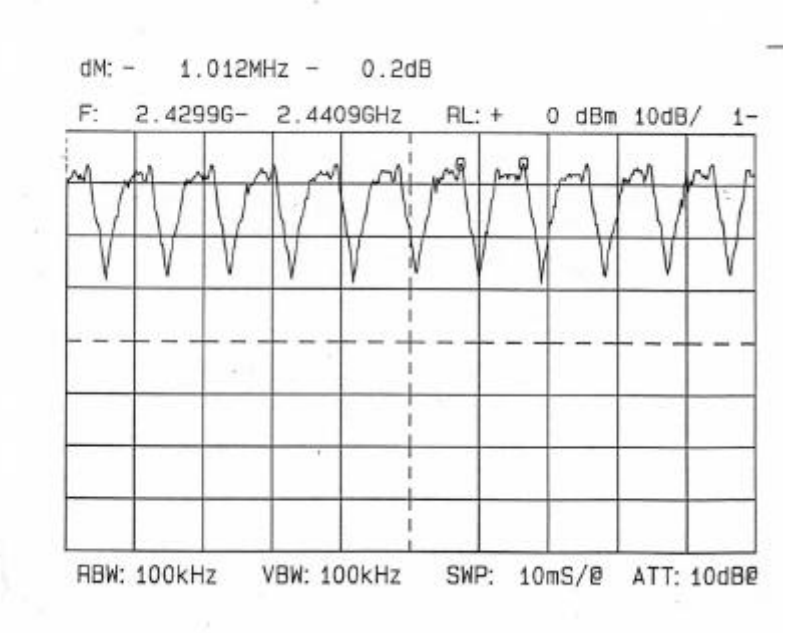
Plot 4.1.3

Test specification: § 15.247(a)(1)(ii)
Hopping channels separation test results



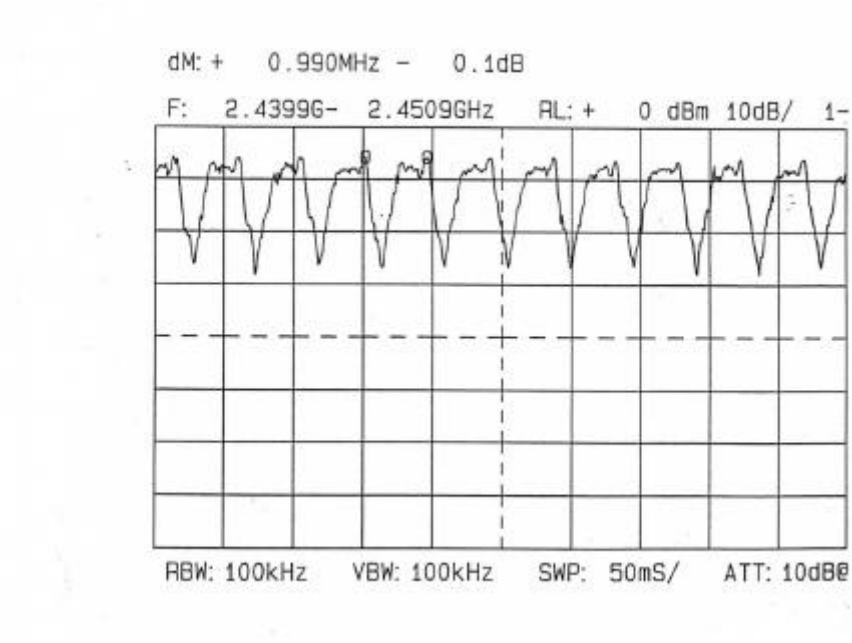
Plot 4.1.4

Test specification: § 15.247(a)(1)(ii)
Hopping channels separation test results



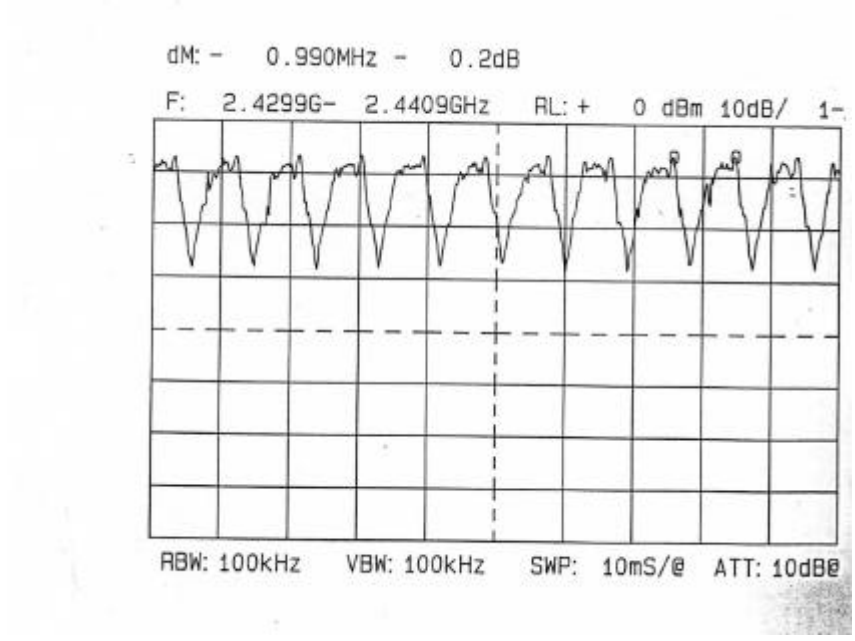
Plot 4.1.5

Test specification: § 15.247(a)(1)(ii)
Hopping channels separation test results



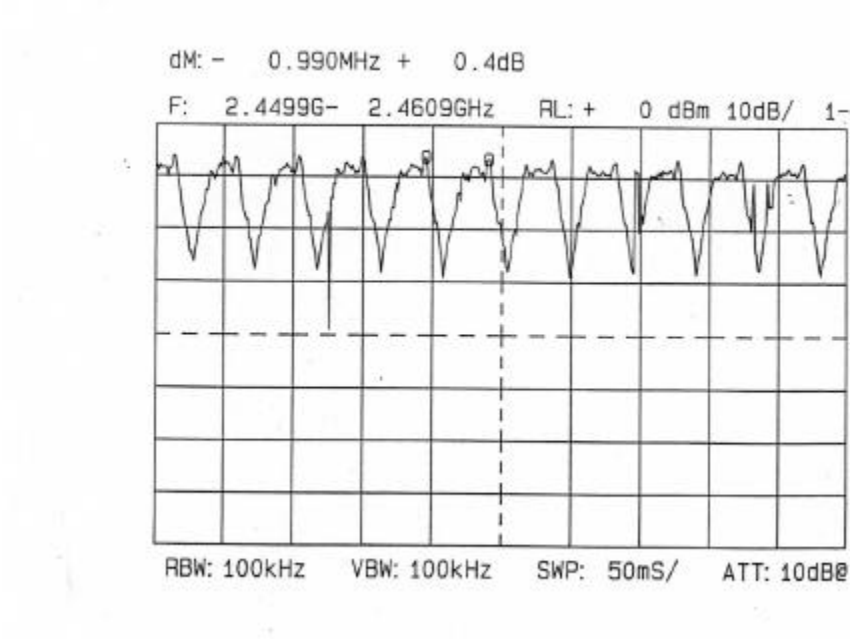
Plot 4.1.6

Test specification: § 15.247(a)(1)(ii)
Hopping channels separation test results



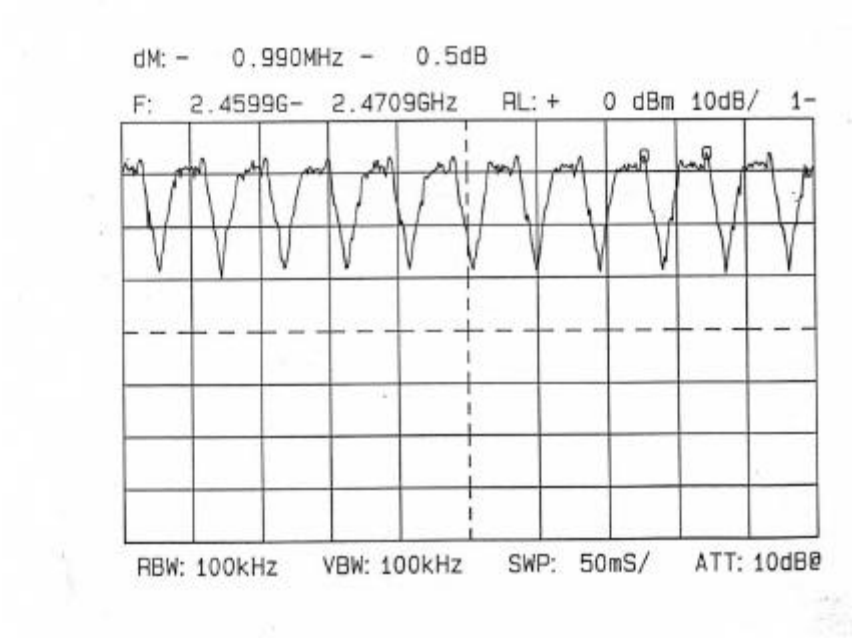
Plot 4.1.7

Test specification: § 15.247(a)(1)(ii)
Hopping channels separation test results



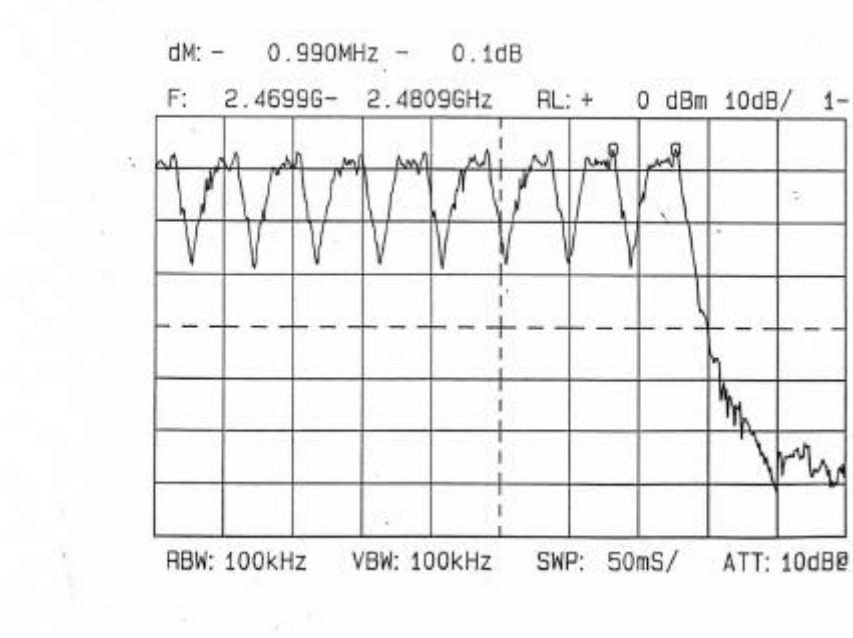
Plot 4.1.8

Test specification: § 15.247(a)(1)(ii)
Hopping channels separation test results



Plot 4.1.9

Test specification: § 15.247(a)(1)(ii)
Hopping channels separation test results



4.2 Occupied bandwidth test according to § 15.247(a)(1)(ii)

4.2.1 General

This test was performed to prove that the maximum 20 dB bandwidth of the hopping channel is less than 1 MHz.

4.2.2 Test pocedure

The test setup was the same as in test 4.1.

The measurements were performed in normal mode of operation with 115 kbit/sec rate. The occupied bandwidth measurement was performed for carrier (channel) frequency at low and high edges and at the middle of the frequency band. Table 4.2.1 and Plots 4.2.1 to 4.2.3 demonstrate the test results of the occupied bandwidth measurements. The spectrum analyzer settings are shown in plots.

Table 4.2.1 Occupied bandwidth test results

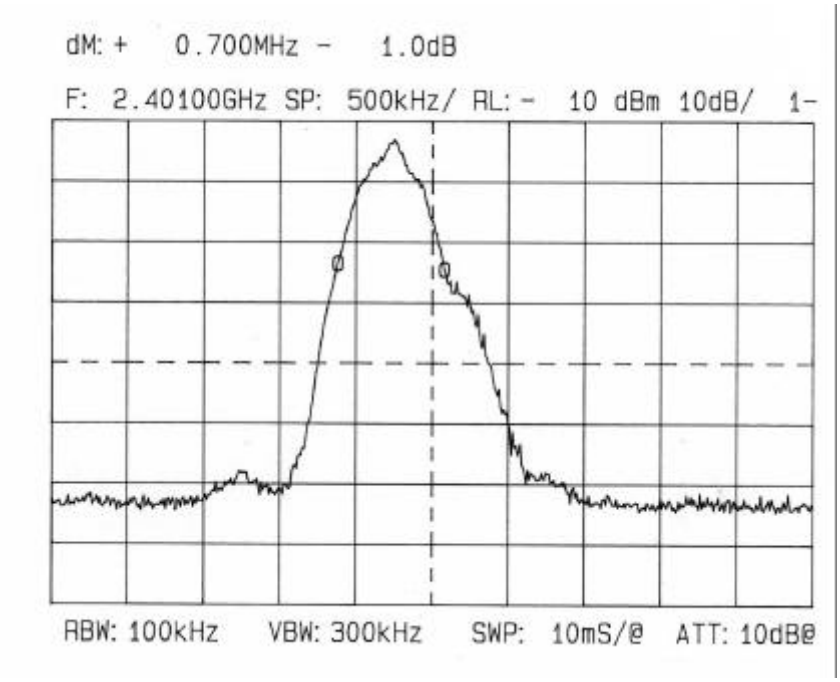
Carrier frequency, MHz	Measured 20 dB BW, kHz	Limit, kHz	Result
2401	700	1000	Pass
2440	830	1000	Pass
2483	890	1000	Pass

Reference numbers of test equipment used

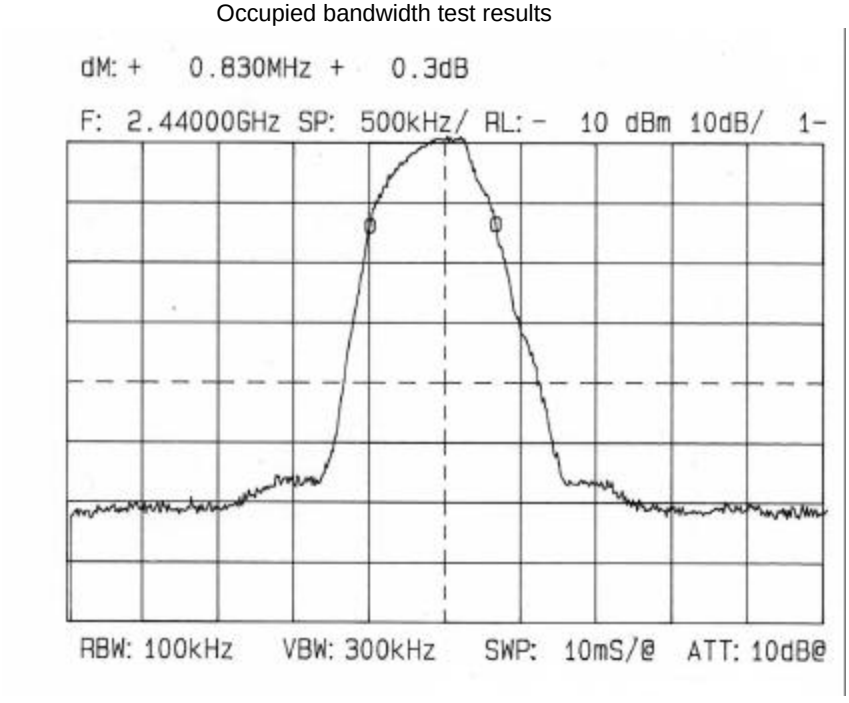
HI 0025	HL 0056	HL 0872

Full description is given in Appendix A.

Plot 4.2.1
Test specification: § 15.247(a)(1)(ii)
Occupied bandwidth test results

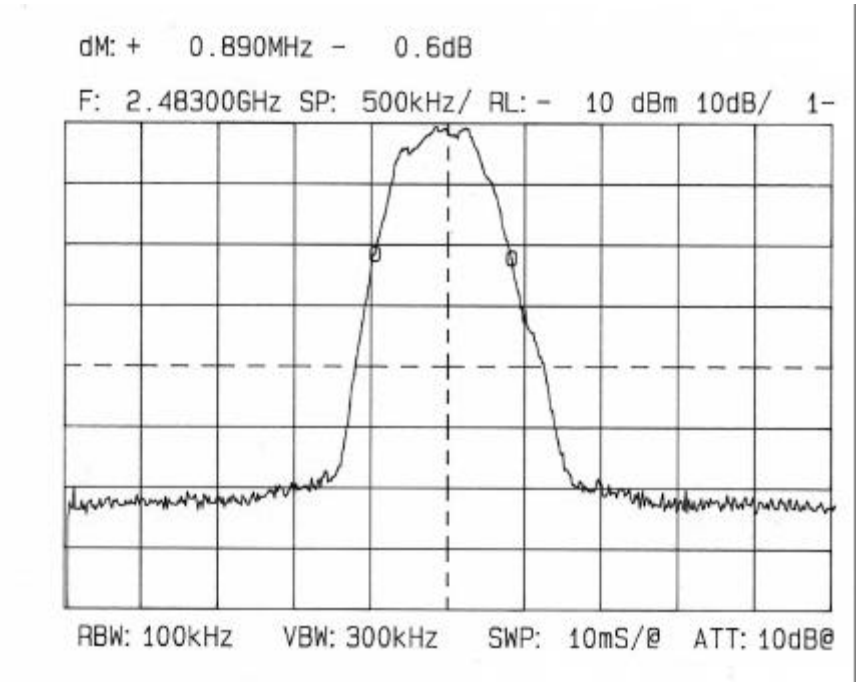


Plot 4.2.2
Test specification: § 15.247(a)(1)(ii)
Occupied bandwidth test results



Plot 4.2.3

Test specification: § 15.247(a)(1)(ii)
Occupied bandwidth test results



4.3 Average time of occupancy, definition according to § 15.247(a)(1)(ii)

4.3.1 General

The test was performed to prove that the average time of occupancy at any frequency is not greater than 0.4 seconds within any 30 second period.

4.3.2 Test procedure

The test setup was the same as in test 4.1 with additional oscilloscope connected to the spectrum analyzer video output.

The average occupancy time (AOT) was calculated from the following equation:

AOT = RR x PD x 30000 ms, where

RR is measured repetition rate,
PD is measured pulse duration.

Plot 4.3.1 shows the time between two pulses (delta T) 156 ms, thus RR = 1 pulse /156 ms.
The Plot 4.3.2 shows the pulse duration equal to 0.89 ms.

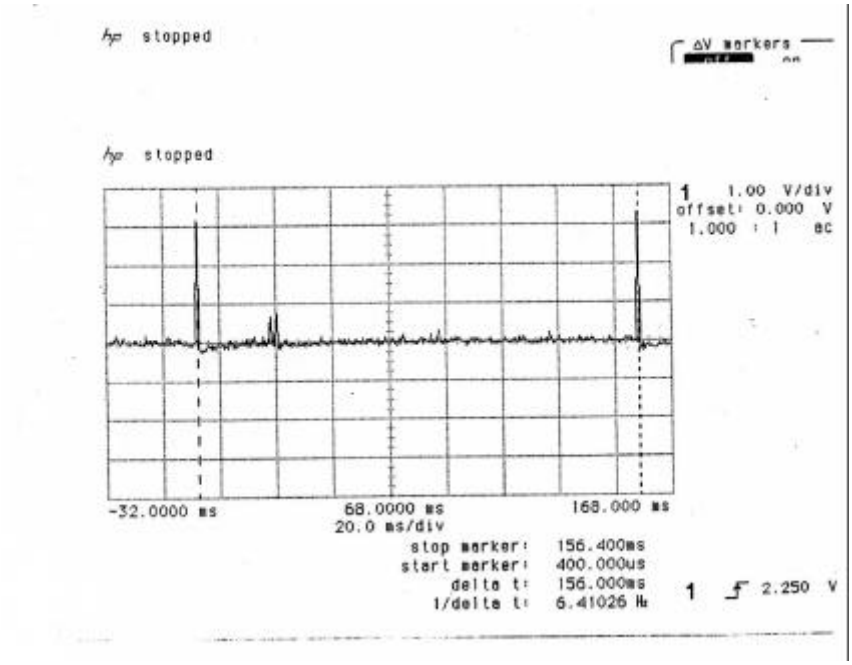
AOT = (1 pulse/156 ms) x 0.89 ms x 30000 ms = 171 ms < 400 ms, as required.

Reference numbers of test equipment used

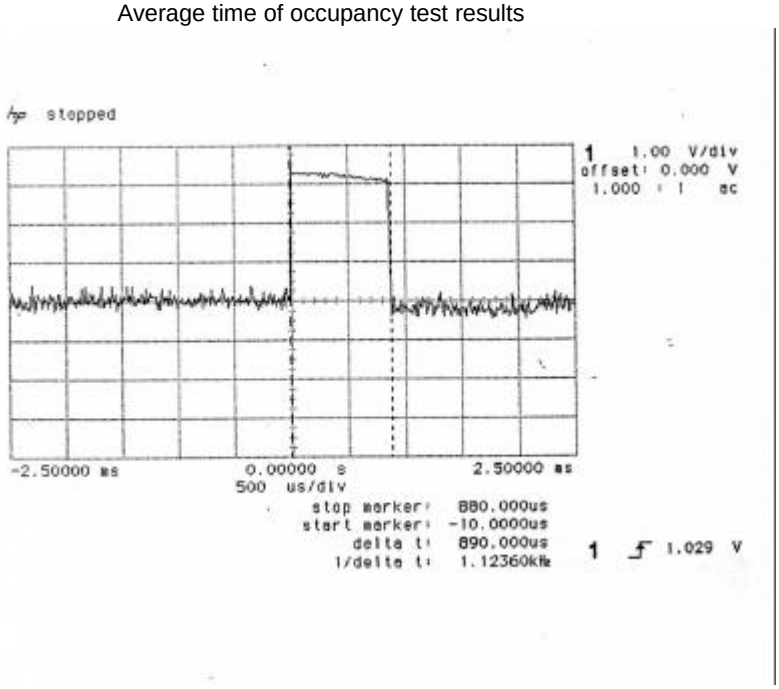
HL 0025	HL 0056	HL 0181	HL 0872

Full description is given in Appendix A.

Plot 4.3.1
Test specification: § 15.247(a)(1)(ii)
Average time of occupancy test results



Plot 4.3.2
Test specification: § 15.247(a)(1)(ii)
Average time of occupancy test results



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

4.4.1 General

This test was performed to demonstrate that the maximum RF peak output power of the transmitter does not exceed 1 W (30 dBm) (§15.247 (1)).
If the transmitting antenna of directional gain greater than 6 dBi is used, the peak output power of the intentional radiator shall be reduced below the stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi (§15.247 (3)).
In our case antenna gain is 11 dBi, hence the maximum peak output power of the transmitter shall not exceed 30 – (11-6) = 25 dBm.

4.4.2 Test procedure

The test setup was the same as in test 4.1.

All measured results are given in Plots 4.4.1 to 4.4.3 and in Table 4.4.1.

Reference numbers of test equipment used

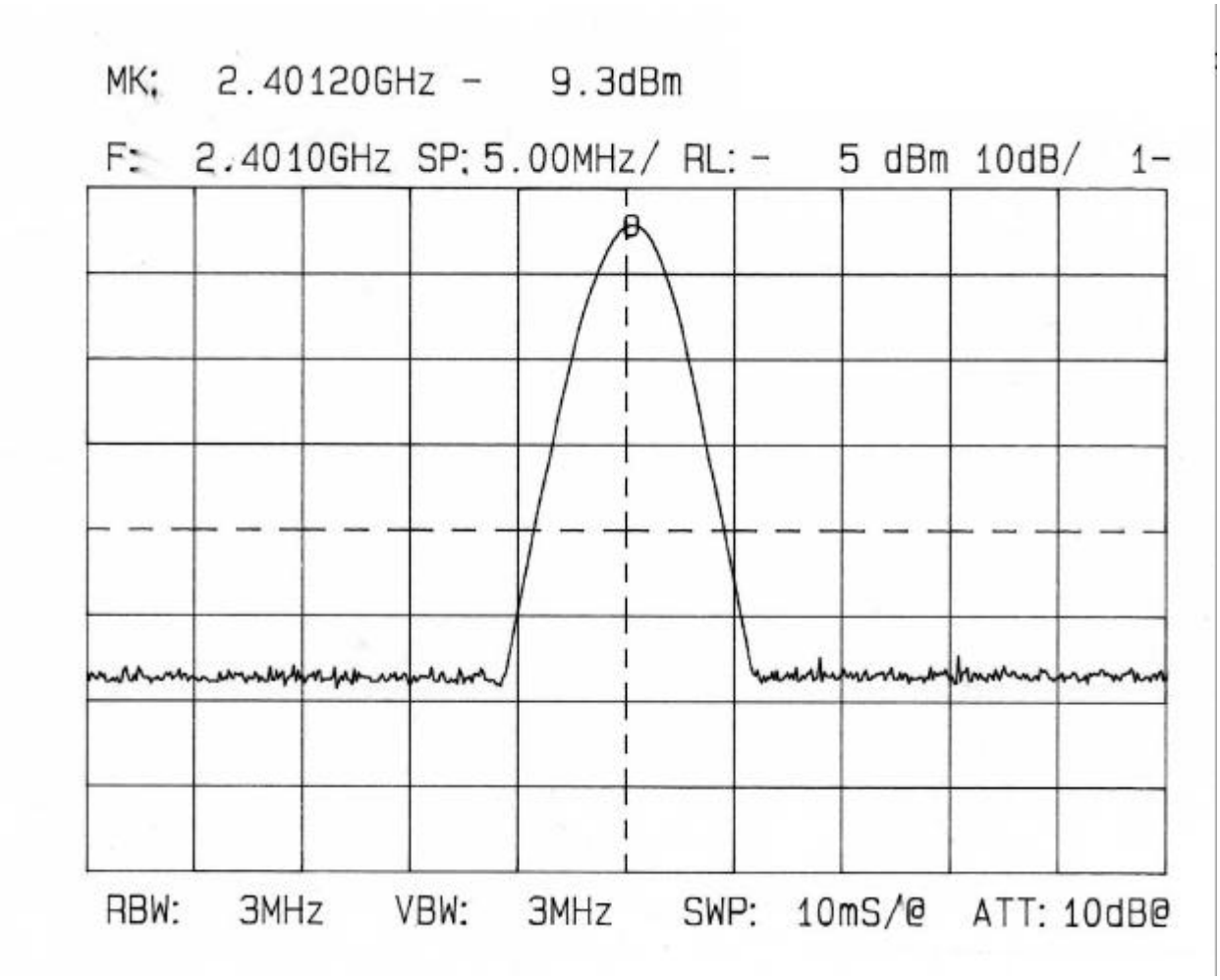
HL 0025	HL 0056	HL 0872

Full description is given in Appendix A.

Table 4.4.1
Transmitter output RF power test results

Frequency, MHz	Peak output power, dBm	Limit, dBm	Margin, dB	Result
2401.2	21.2	25	3.8	Pass
2440.1	20.6	25	4.4	Pass
2483.2	20.7	25	4.3	Pass

Plot 4.4.1
Transmitter output RF power test results



External attenuation = 30.5 dB.

P = -9.3 + 30.5 = 21.2 dBm