ELECTROMAGNETIC EMISSIONS TEST REPORT

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

for

BreezeCOM Ltd.

EQUIPMENT UNDER TEST:

WIRELESS ACCESS SYSTEM UNITS
model numbers AU-A/O-2.4,
SU-A/O-xD-2.4, SU-A/O-xD-1V-2.4

Prepared by: ________________
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ACCREDITED 839.01
Electrical

Description of equipment under test

Test items	Frequency hopping transceiver of wireless access system units
Manufacturer	BreezeCOM Ltd.
Types (models)	AU-A/O-2.4 SU-A/O-xD-2.4 SU-A/O-xD-1V-2.4

Applicant information

Applicant’s representative	Mr. Eitan Lazarov, project manager
Applicant’s responsible person	Mr. Itzik Raiskin, RF group manager
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Test performance

Project numbers	13399, 13405, 13420, 13499
Location	Hermon Laboratories
Test started	May 2, 1999
Test completed	June 15, 1999
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, 15.207, 15.209, 15.107, 15.109

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 a point is used as the decimal separator and the thousands are counted with a comma.
This report is in conformity with EN 45001 and ISO GUIDE 25.
The test results relate only to the items tested.

Table of Contents

1 General information

1.1 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
GND	grounding
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
QP	quasi-peak (detector)
PC	personal computer
pF	picofarad
RBW	resolution bandwidth
RF	radio frequency
RE	radiated emission
sec	second
UTP	unshielded twisted pair
V	volt
V/m	volt per meter
W	watt

1.2 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.

1.3 EUT description

The BreezeACCESS IP Broadband Wireless Local Loop (WLL) system is a high-performance wireless access system. It provides high-speed wireless connectivity services. The BreezeACCESS system access units (AU) allow remote subscriber units (SU) to communicate over the wireless infrastructure at data rates of up to 3Mbps. The BreezeACCESS products use a frequency hopping transceiver operating in the 2.4 to 2.4835 GHz frequency band with GFSK type of modulation: 2FSK@1 Mbps, 4FSK@2 Mbps, 8FSK@3 Mbps. The frequency order is pseudorandom.
Access units are installed at the base station site and comprised of an indoor unit and an outdoor unit. The AU-O 2.4 outdoor unit can be connected to one or two separate antennas. The indoor unit connects to the Ethernet hub, switch or router.

The difference between the SU-A-D/DV series and the SU-O-D/DV series is in the structure of the outdoor unit: the outdoor unit of the SU-A-D/DV products includes an integrated antenna, while the outdoor unit of the SU-O-D/DV line of products does not include an antenna.
The indoor units of both the SU-A-D/DV and the SU-O-D/DV series provide interfaces to user's equipment. In addition, the indoor unit provides 48 V DC to the outdoor unit.
The SU-A-D/DV and the SU-O-D/DV products, through the Ethernet port, provide all the functionality required to connect workstation computers and other Ethernet equipment at the subscriber premises to the network. SU-A-DV and SU-O-DV products provide the same data functionality, plus a telephone interfaces supporting regular telephones.

The **SU-A/O-xD-2.4 series** include the following products:

- SU-A/O-1D-2.4-110: supports a single Ethernet workstation/PC
- SU-A/O-4D-2.4-110: supports up to 4 Ethernet workstations/PCs
- SU-A/O-8D-2.4-110: supports up to 8 Ethernet workstations/PCs
- SU-A/O-16D-2.4-110: supports up to 16 Ethernet workstations/PCs
- SU-A/O-BD-2.4-110: supports a LAN (a bridge functionality)

The **SU-A/O-xD1V-2.4 series** have in addition voice port and include the following products:

- SU-A/O-1D1V-2.4 supports a single Ethernet workstation and a regular telephone interface
- SU-A/O-4D1V-2.4-110: supports up to 4 Ethernet workstations/PCs and a regular telephone interface
- SU-A/O-8D1V-2.4-110: supports up to 8 Ethernet workstations/PCs and a regular telephone interface
- SU-A/O-16D1V-2.4-110: supports up to 16 Ethernet workstations/PCs and a regular telephone interface
- SU-A/O-BD1V-2.4-110: supports a LAN (a bridge functionality) and a regular telephone interface.

AU-A-2.4-110, SU-A-2.4-xD1V-110 and SU-A-2.4-xD-110 outdoor units are integrated with 16dBi antenna.
The AU-O-2.4-110 and SU-O-xD1V-2.4-110 outdoor units doesn't include integral antenna.
The hardware of the outdoor unit in the AU-O/A-2.4-110, SU-O/A-2.4xD-110 is identical.
SU-O/A-xD1V has in addition voice port.
All products have the same RADIO.

The indoor unit of AU-O-2.4-110 and SU-O/A-2.4-xD-110 are identical. They include outdoor unit connector, mains input connector and network Ethernet connector.
The indoor unit of the SU-O/A-xD1V-2.4-110 includes a telephone connector as well as all other connectors.

The information about used antennas is provided in the attached application documentation. The EUT is powered from 120 V AC.

1.3.1 Changes made in EUT

To withstand the FCC part 15 requirements the following changes were made in the EUT of **AU-O-2.4 series**:

1) the two capacitors, 20 nF and 1.8 nF, connected in parallel, were installed between phase and ground as well as between neutral and ground;
2) an additional filter was installed on the DC/DC converter – the schematic diagram is provided in the attached application documentation.

To withstand the FCC part 15 requirements the following changes were made in the EUT of **SU-A/O-xD1V-2.4 series**:

1) the 1.2 pF capacitor, type COG, size 0603, manufactured by Murata was installed at the transmitter RF output;
2) three ferrite beads, manufactured by Fair-Rite, P/N 0443164251, were installed at the external Ethernet cable inside the case, close to the output;
3) the 2.4 – 2.5 GHz band pass filter manufactured by Murata, was added to the RF output;
4) the Ethernet cable from Breezenet-card to IA_ODU-card was changed for the shielded one;
5) the audio code component was shielded from the component side of MAC-card.
6) the two capacitors, 20 nF and 1.8 nF, connected in parallel, were installed between phase and ground as well as between neutral and ground;

7) an additional filter was installed on the DC/DC converter – the schematic diagram is provided in the attached application documentation.

To withstand the FCC part 15 requirements the following changes were additionally made in the EUT of **SU-A-xD-2.4 series**:

1) integral antenna was connected to "Ant.2" output of Phy-radio board
2) shielded lid was installed on Phy-radio board to enclose RF part from two sides
3) Motorola MC68EN360 microprocessor main program was changed: the CLK output was inverted to disable mode.

1.4 EUT test configuration

The EUT ports and lines description is given in Tables 1.1 to 1.4, the support/test equipment description is given in Table 1.5.
The EUT test configuration is shown in Figures 1.1, 1.2.
Full testing was performed on the each series testsample and the worst test results are brought in this test report.

Table 1.1
SU-A-xD-1V ports and lines

Connector type	Port description	Quantity	Cable type description	Cable length, m	Connected to
IEC 320 inlet	power	1	unshielded-	1.5	mains
D-9 type (indoor unit)	radio	1	shielded	30	outdoor unit
RJ-45	Ethernet	1	UTP	1.5	PC
RJ-11	phone	1	UTP	2.0	telephone

Table 1.2
SU-O-xD-1V ports and lines

Connector type	Port description	Quantity	Cable type description	Cable length, m	Connected to
IEC 320 inlet	power	1	unshielded	1.5	mains
D-9 type (indoor unit)	radio	1	shielded	5	outdoor unit
RJ45	Ethernet	1	UTP	2	Ethernet
RJ11	telephone	1	UTP	2	telephone
N-type	antenna	2	Heliax	10	antenna

Table 1.3
AU-A & SU-A-xD ports and lines

Connector type	Port description	Quantity	Cable type description	Cable length, m	Connected to
IEC 320 inlet	power	1	unshielded	1.5	mains
D-9 type (indoor unit)	radio	1	shielded	5	outdoor unit
RJ45	Ethernet	1	UTP	2	Ethernet

Table 1.4
AU-O & SU-O-xD ports and lines

Connector type	Port description	Quantity	Cable type description	Cable length, m	Connected to
IEC 320 inlet	power	1	unshielded	1.5	mains
D-9 type (indoor unit)	radio	1	shielded	5	outdoor unit
RJ45	Ethernet	1	UTP	2	Ethernet
N-type	Antenna	2	Heliax	10	antenna

Table 1.5
EUT support/test equipment

Description	Manufacturer	Model number	Serial number	FCC ID number
Personal Computer	Siemens Nixdorf	Scenic Pro M5	QK079816	HSSSCENICM501
Monitor 15"	Seimens Nixdorf	MCM 1503 NTD	BW397726	GWGPAXCAX1415C
Mouse	Microsoft	9741	00381045	C3KKMP3
Keyboard	Seimens Nixdorf	S26381-K252-V188	NA	0G6C1KMPII
Printer	EPSON	LX-810	44B1127035	NA
Modem	US Robotics	0459	NA	CJEUSA-24375-MS-E

Figure 1.1
SU-A-xD and SU-A-xD1V test configuration

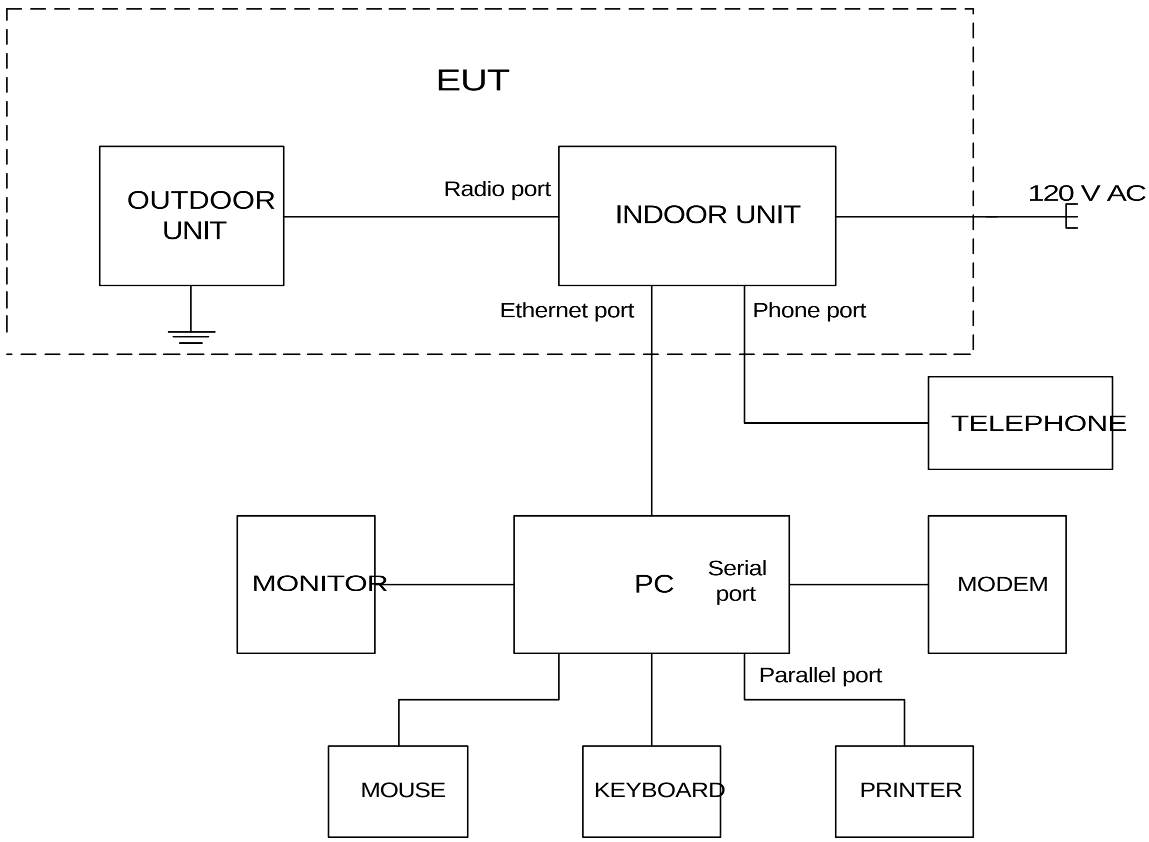
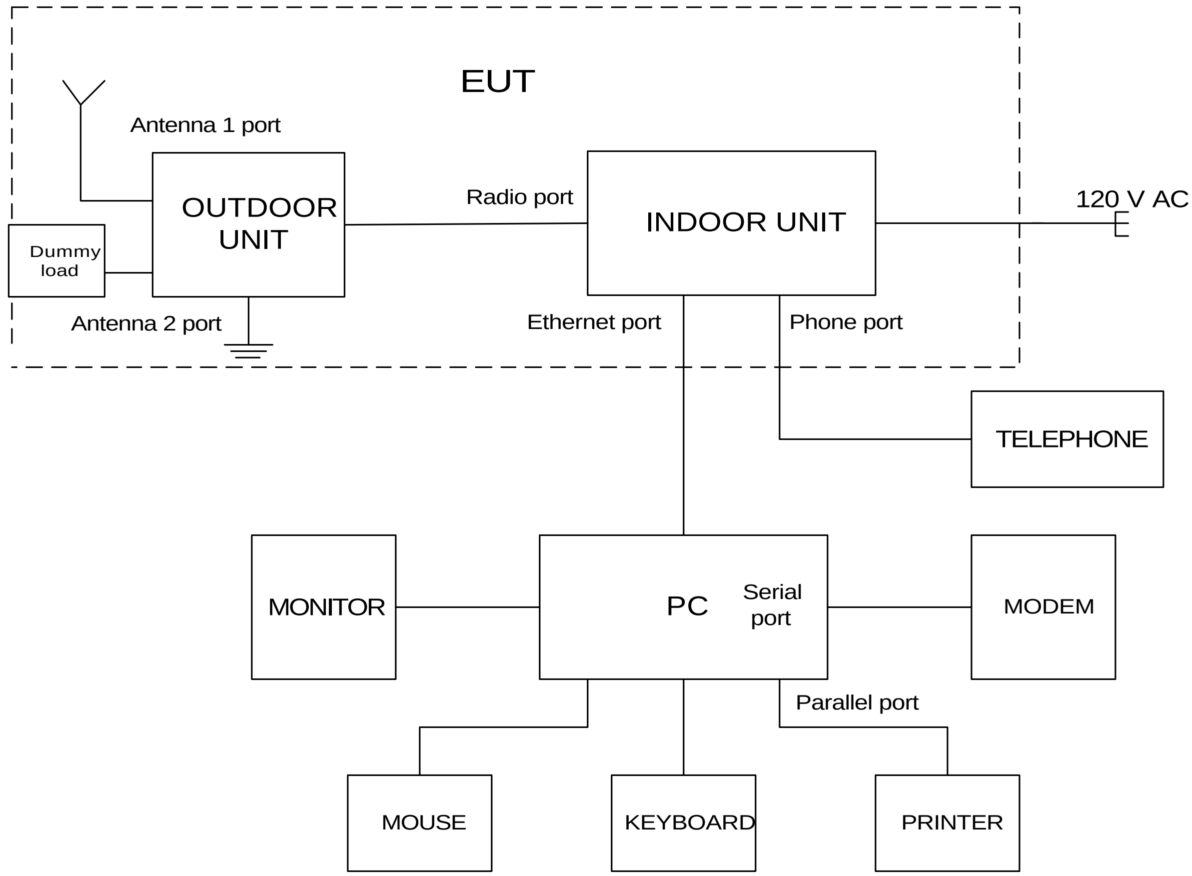


Figure 1.2
AU-O, SU-O-xD and SU-O-xD1V test configuration



2 Test facility description

2.1 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).

Address: PO Box 23, Binyamina 30550, Israel
Telephone: +972 6628 8001
Fax: +972 6628 8277
Person for contact: Mr. Alex Usoskin, testing and QA manager.

2.2 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.

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

Conducted emissions with LISN	9 kHz to 30 MHz: ± 2.1 dB
Radiated emissions in the open field test site at 10 m measuring distance Radiated emissions in the anechoic chamber at 3 m measuring distance	Biconilog antenna: ±3.2 dB Log periodic antenna: ±3 dB Biconical antenna: ±4 dB Biconilog antenna: ±3.2 dB Double ridged guide antenna: ± 2.36 dB

2.3 Laboratory personnel

The three people of Hermon Laboratories that have participated in measurements and documentation preparation are: Dr. Edward Usoskin - C.E.O., Mr. Michael Nikishin - test engineer and Mrs. Marina Cherniavsky – certification engineer. Dr. E. Usoskin is an EMC specialist, M Nikishin is an EMC accredited test laboratory engineer and M. Cherniavsky is

a telecommunication engineer, certified by the National Association of Radio and Telecommunications Engineers (NARTE, USA.).
The Hermon Laboratories personnel that participated in this project have more than 70 years combined experience time in EMC measurements and electronic products design.

2.4 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 1996 with an M. Sc. EE degree and certified by the National Association of Radio and Telecommunications Engineers, Inc. as an EMC accredited test laboratory engineer, the certificate no. is ATL–0005–E.
I have obtained 2 years experience in EMC measurements and have been with Hermon Laboratories since 1998.

Name: Mr. Michael Nikishin Signature:
Position: test engineer Date: August 24, 1999

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 am an engineer, graduated from university in 1971, with an MScEE degree, have obtained 26 years experience in electronic products design and development and have been with Hermon Labs since 1991. Also, I am a telecommunication class II engineer certified by the National Association of Radio and Telecommunications Engineers, Inc. (USA.), the certificate no. is E2-03410.

Name: Mrs. Marina Cherniavsky Signature:
Position: certification engineer Date: August 24, 1999

I hereby certify that this test measurement report was prepared under my direction and that to the best of my knowledge and belief, the facts set in the report and accompanying technical data are true and correct.
The following is a statement of my qualifications.
I have a Ph.D. degree in electronics, have obtained more than 42 years of experience in EMC measurements and electronic product design and have been with Hermon Laboratories since 1986.
Also, I am an EMC engineer certified by the National Association of Radio and Telecommunications Engineers, Inc. (USA). The certificate no. is EMC-000623-NE, Senior Member.

Name: Dr. Edward Usoskin Signature:
Position: C.E.O. Date: August 24, 1999

3 Emission measurements

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

3.1.1 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.

3.1.2 Test set-up

The EUT RF output was connected to the spectrum analyzer through 30 dB attenuator as shown in Photographs 3.1.1, 3.1.2.
All the spectrum analyzer settings are shown in the plots.

3.1.3 Test results

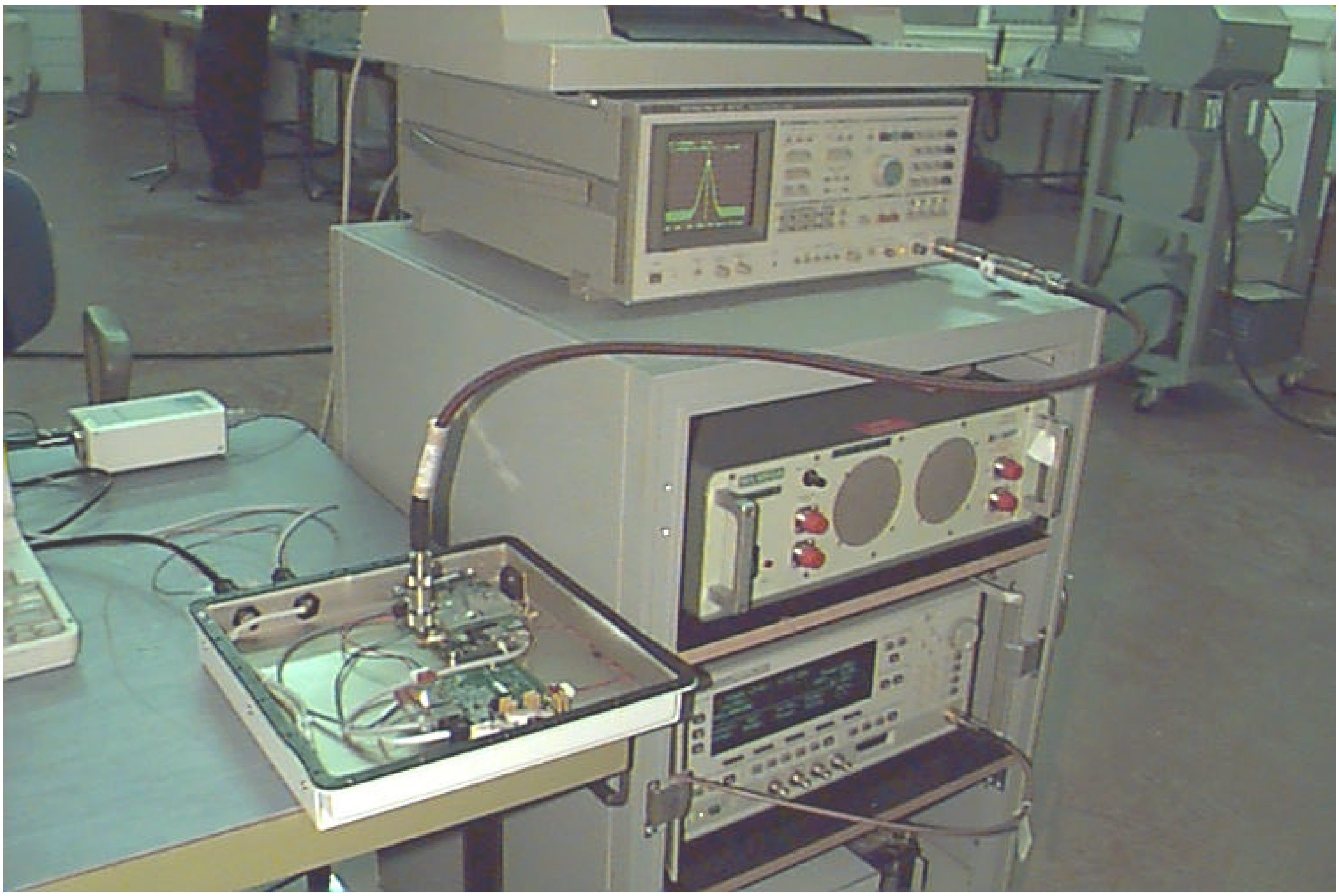
The nine Plots 3.1.1 to 3.1.9 show 79 channels and the 1 MHz spacing between carriers which are greater than 75 channels and 20 dB channel occupied bandwidth separation (0.968 MHz maximum, see Table 3.2.1) required by the standard. The EUT successfully passed this test.

Reference numbers of test equipment used

HL 0025	HL 0056	HL 0411				

Full description is given in Appendix A.

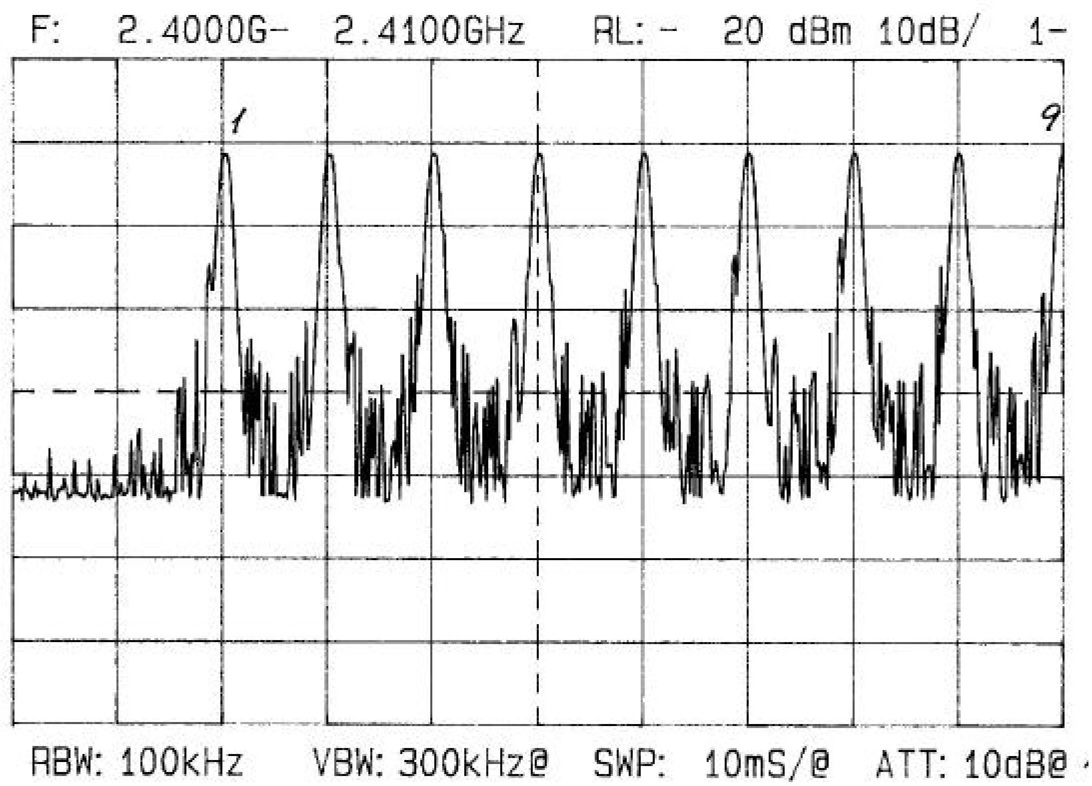
Photograph No. 3.1.1
Frequency hopping channels separation measurements setup
with integral antenna



Photograph No. 3.1.2
Frequency hopping channels separation measurements setup
with external antenna

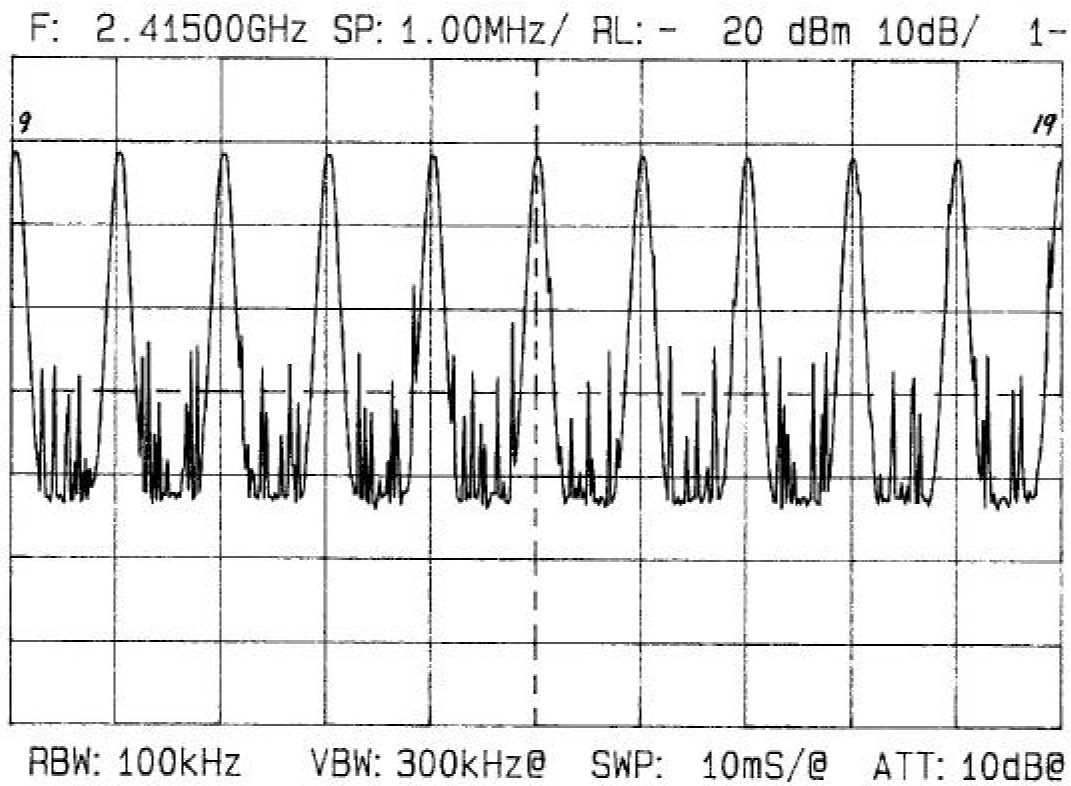
Plot 3.1.1

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



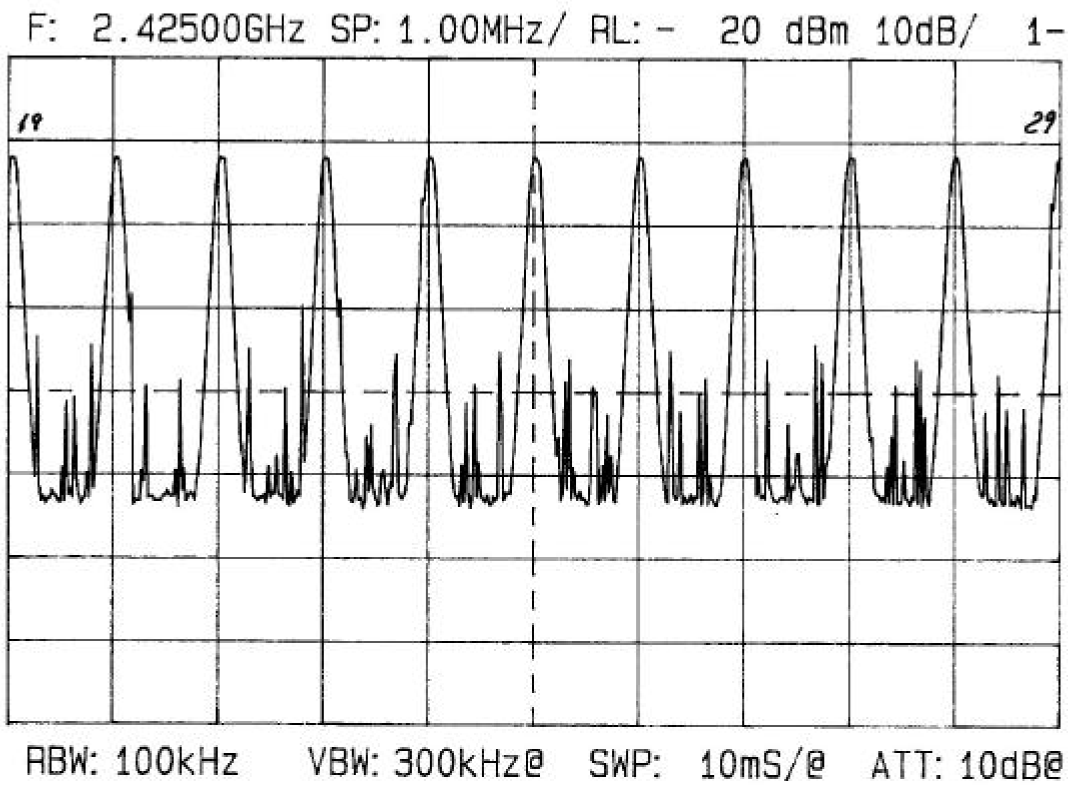
Plot 3.1.2

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



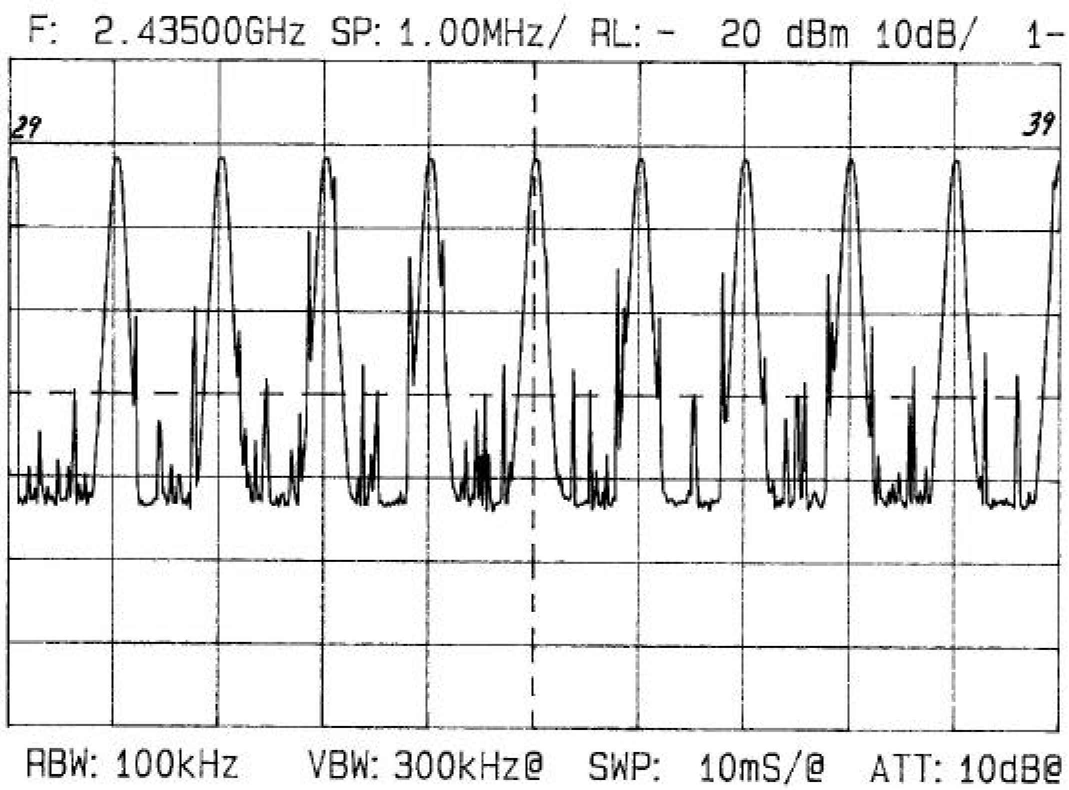
Plot 3.1.3

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



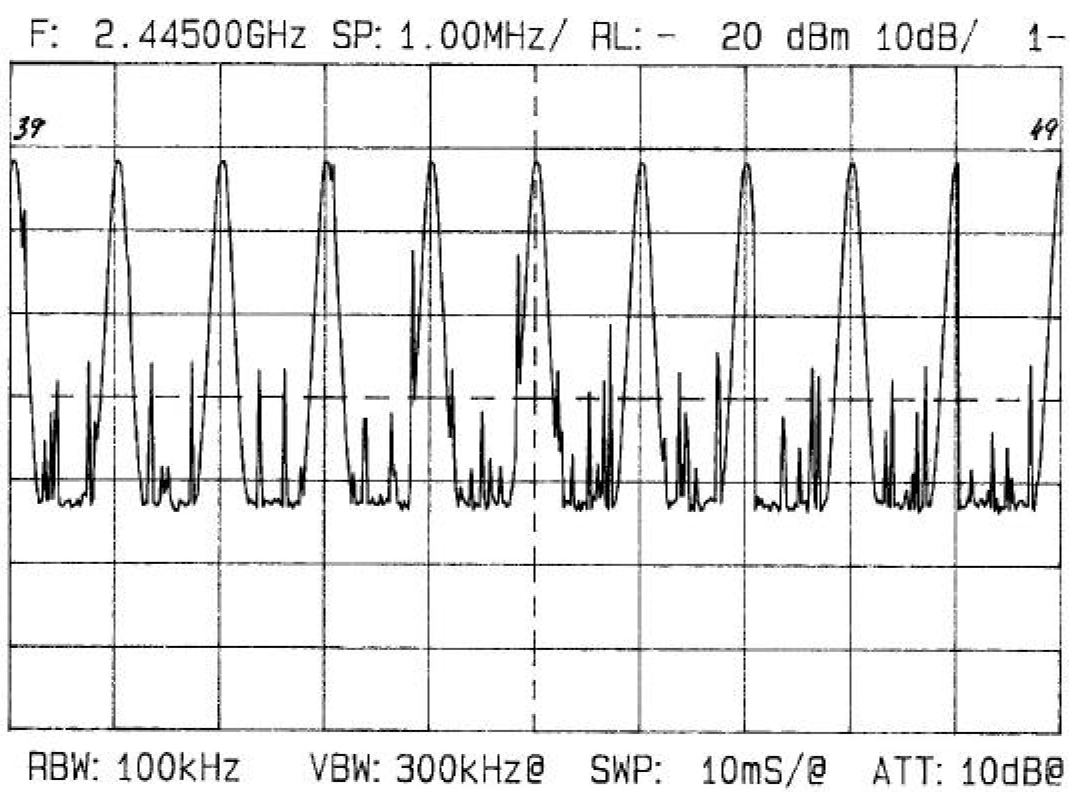
Plot 3.1.4

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



Plot 3.1.5

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



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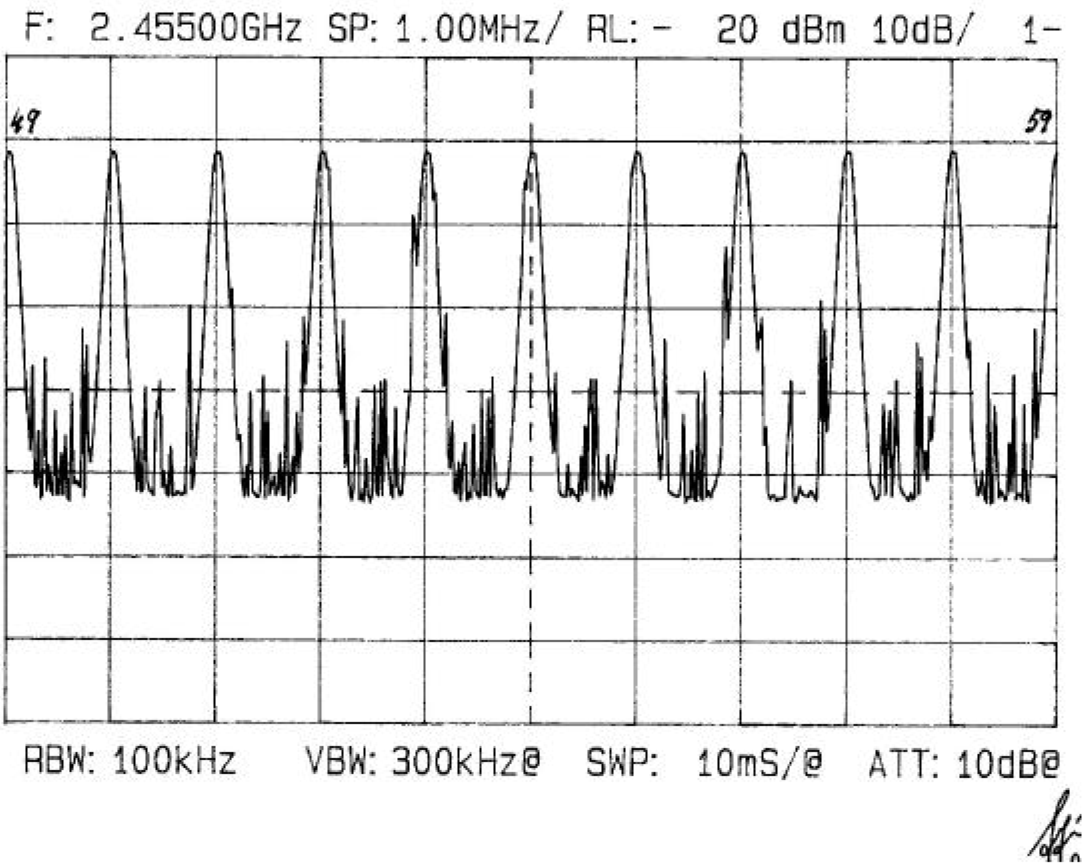
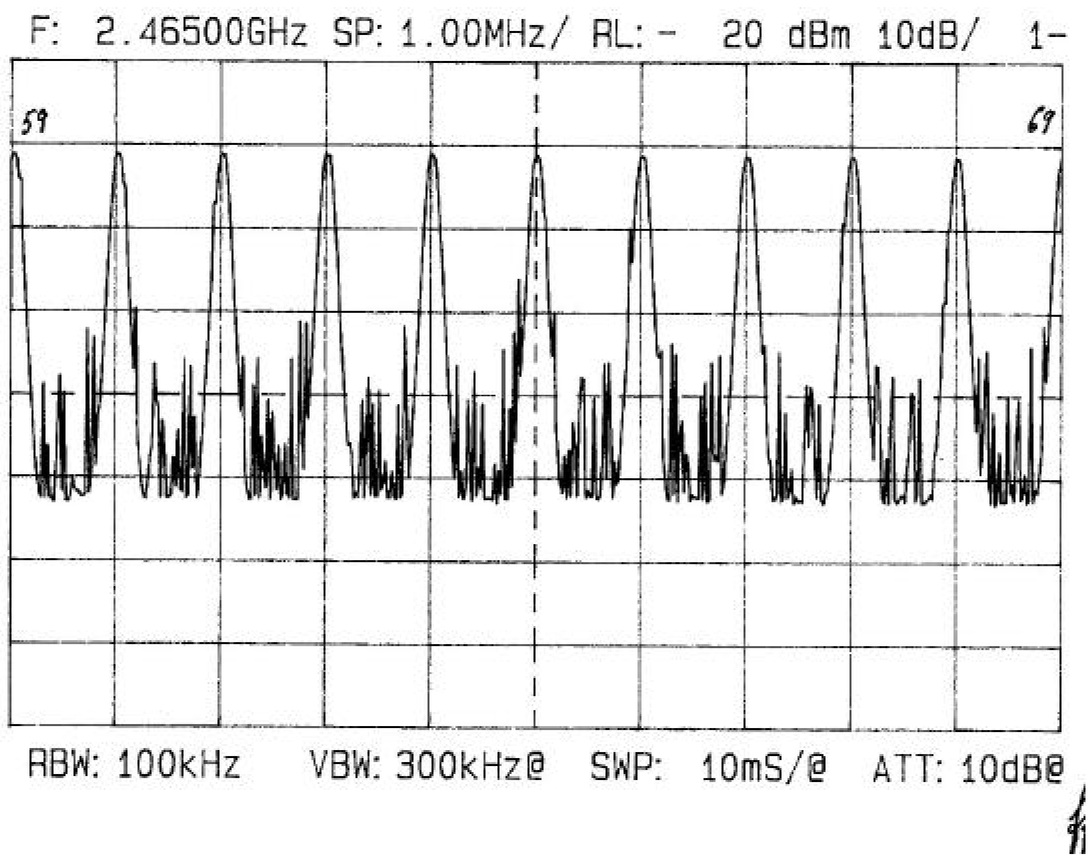
Plot 3.1.6

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



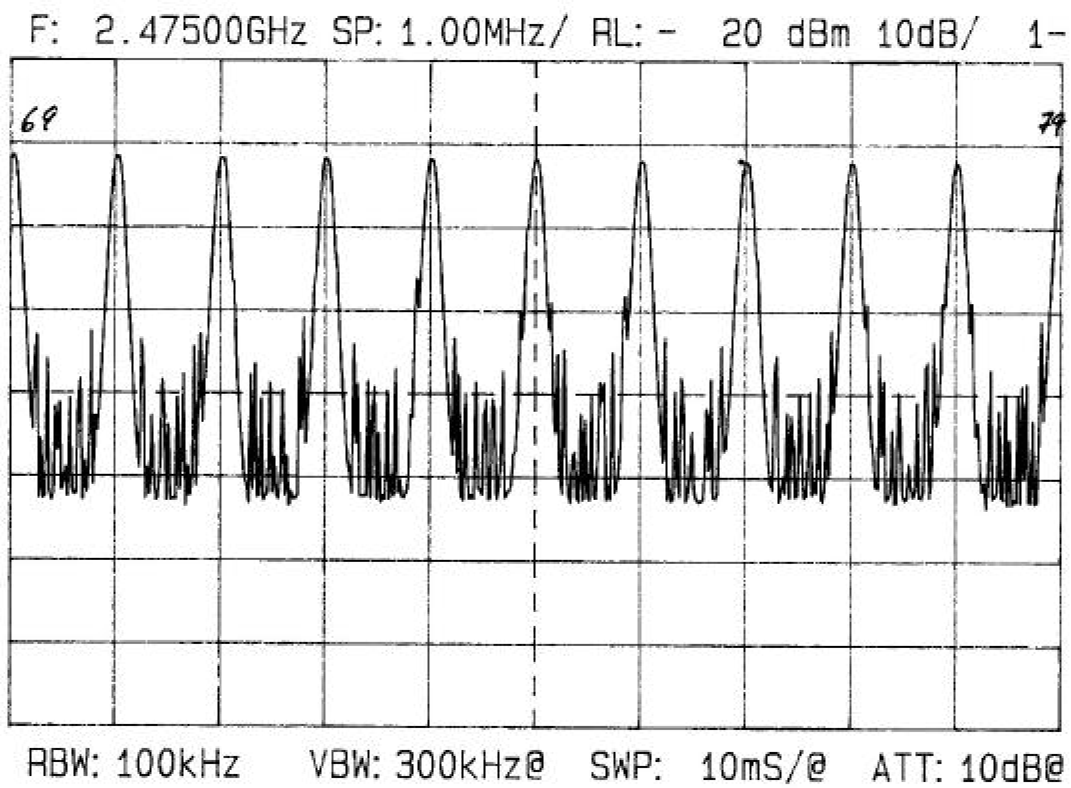
Plot 3.1.7

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



Plot 3.1.8

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



Plot 3.1.9

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