Global EMC Inc. Labs

EMC & RF Test Report

As per

RSS 210 Issue 7:2007

&

FCC Part 15 Subpart C: 2006

Unlicensed Intentional Radiators

on the

Lyngsoe Systems Handheld scanner

TT8350LSA

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Testing produced for

Lyngsoe Systems
elevating logistics

See Appendix A for full customer & EUT details.

Industry Canada
LAB REGISTRATION #6844A-1

FCC REGISTRATION #612361

ACCREDITED
TESTING LABORATORY
CERTIFICATE #2565.01

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Report Scope

This report addresses the EMC verification testing and test results of the Lyngsoe Systems Handheld scanner TT8350LSA, herein referred to as EUT (Equipment Under Test) performed at Global EMC Labs.

The EUT was tested for compliance against the following standards:

RSS 210 Issue 7:2007 / FCC Part 15 Subpart C 15:2006

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

The results contained in this report relate only to the item(s) tested.

This report does not imply product endorsement by A2LA or any other accreditation agency, any government, or Global EMC Inc.

Opinions/interpretations expressed in this report, if any, are outside the scope of Global EMC Inc accreditation. Any opinions expressed do not necessarily reflect the opinions of Global EMC Inc, unless otherwise stated.

Client	Lyngsoe Systems
Product	TT8350LSA
Standard(s)	RSS 210 Issue 7:2007 / FCC Part 15 Subpart C 15:2006

Summary

The results contained in this report relate only to the item(s) tested.

EUT FCC Certification #, FCC ID:	PQG-TT8350LSA
EUT Industry Canada Certification #, IC:	4113A-TT8350LSA
EUT Passed all tests performed.	Yes (see test results summary)
Tests conducted by	Ashwani Malhotra

Client	Lyngsoe Systems
Product	TT8350LSA
Standard(s)	RSS 210 Issue 7:2007 / FCC Part 15 Subpart C 15:2006

Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 15.203 RSS 210 Section 5.5	Antenna Requirement	Permanently connected	Pass See Justification
FCC 15.205 RSS 210 Section 6.3 (Table 2)	Restricted Bands for intentional operation	None within chart	Pass See description
FCC 15.207 RSS 210 Section 6.6	Power line conducted emissions	QuasiPeak Average	Pass
FCC 15.209 RSS 210 Section 6.2.1 (Tables 3 & 7)	Radiated emissions	QuasiPeak Average	Pass
FCC 15.247(a)(1) RSS 210 6.2.2(o)	Channel Separation	> 20db BW of channels	Pass
FCC 15.247(a)(1)(i) RSS 210 6.2.2(o)	Number of channels	>= 50	Pass
FCC 15.247(a)(1)(i) RSS 210 6.2.2(o)	Time of occupancy	< 400 mSec in 20 sec period	Pass
FCC 15.247(b) RSS 210 6.2.2(o)	Max output power	< 1 Watt	Pass
FCC 15.247(b)(4) RSS 210 6.2.2(o)	Antenna Gain	< 6 dBi	Pass See Justification
FCC 15.247(d) RSS 210 6.2.2(d)	Antenna conducted spurious	> 20 dBc	Pass
FCC 15.247(h)	FHSS Intelligence	No coordination	Pass See Justification
FCC 15.247(i) IC Safety code 6	Maximum Permissible Exposure	> 2.50 cm separation.	Pass See justification and calculations
Overall Result			**PASS**

All tests were performed by Ashwani Malhotra.

If the product as tested or otherwise complies with the specification, the EUT is deemed to comply with the requirement and is deemed a ‘PASS’ grade. If not ‘FAIL’ grade will be issued.

Justifications, Descriptions, or Deviations

The following justifications for tests not performed or deviations from the above listed specifications apply:

For the Antenna requirement specified in FCC 15.203 (RSS 210 section 5.5), the manufacturer has a permanently connected antenna which is not accessible to the end user.

For the Restricted Bands of operation, the EUT is designed to only operate between 902 to 928 MHz.

The EUT uses a patch antenna; gain of this is less than 6 dbi. Acutal gain of antenna is 4.1 dbi. The antenna connector is a 50Ω MMCX connector. This connector is not accessible to the user and the antenna is pre-connected.

For maximum permissible exposure, this device operates at less then 1 Watt at 902-928 MHz. No testing is required, however worst case calculated exposure compliance follows later in this report.

The EUT was tested on all 3 axes and the worst case (vertical) is recorded here. The EUT required a ferrite bead on the antenna cable in order to comply spurious radiated emissions.

Applicable Standards, Specifications and Methods

ANSI C63.4:2003	- Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CFR 47 FCC 15	- Code of Federal Regulations – Radio Frequency Devices
CISPR 22:1997	- Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
ICES-003:2004	- Digital Apparatus - Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard
ISO 17025:2005	- General Requirements for the competence of testing and calibration laboratories
RSS 210:2007	- Issue 7: Spectrum Management and Telecommunications Policy. Radio Standards Specification Low Power Licence-Exempt Radiocommunication Devices

Sample calculation(s)

Margin = limit – (received signal + antenna factor + cable loss – pre-amp gain)
Margin = 50.5dBuV/m – (50dBuV + 10dB + 2.5dB – 20dB)
Margin = 8.5 dB

Document Revision Status

Revision 1 - Initial report released October 8th, 2009

Definitions and Acronyms

The following definitions and acronyms are applicable in this report.
See also ANSI C63.14.

AE – Auxiallary Equipment.

BW – Bandwidth. Unless otherwise stated, this is refers to the 6 dB bandwidth.

EMC – Electro-Magnetic Compatibility

EMI – Electro-Magnetic Immunity

EUT – Equipment Under Test

ITE – Information Technology Equipment with a primary function(s) of entry, storage, display, retrieval, transmission, processing, switching, or control, of data.

LISN – Line impedance stabilization network

NCR – No Calibration Required

RF – Radio Frequency

Testing Facility

Testing for EMC on the EUT was carried out at Global EMC labs in Toronto, Ontario, Canada. The testing lab consists of a 3m semi-anechoic chamber calibrated to be able to allow measurements on an EUT with a maximum width or length of up to 2m and height up to 3m. The chamber is equipped with a turn table that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for 120 Vac and 240Vac single phase, or 208 Vac 3 phase input. DC capability is also available. The chamber is equipped with an antenna mast that controls polarization and height from the control room adjoining the shielded chamber. Radiated emissions measurements are performed using a Bilog, and Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN.

Calibrations and Accreditations

The measurement site used is registered with Federal Communications Commission (FCC) and Industry Canada (IC). This site is calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 “Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz”. The semi-anechoic chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test.

Testing Environmental Conditions and Dates

Following were the environmental conditions in the facility during time of testing –

Date	Test	Init.	Temperature (ºC)	Humidity (%)	Pressure (kPa)
Oct 1 – 5, 2008	All	AM	21-23ºC	39.4-42.3%	100.2 - 100.9kPa

Detailed Test Results Section

Spurious Radiated Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

Limit(s) and Method

The method is as defined in ANSI C63.4:2003.

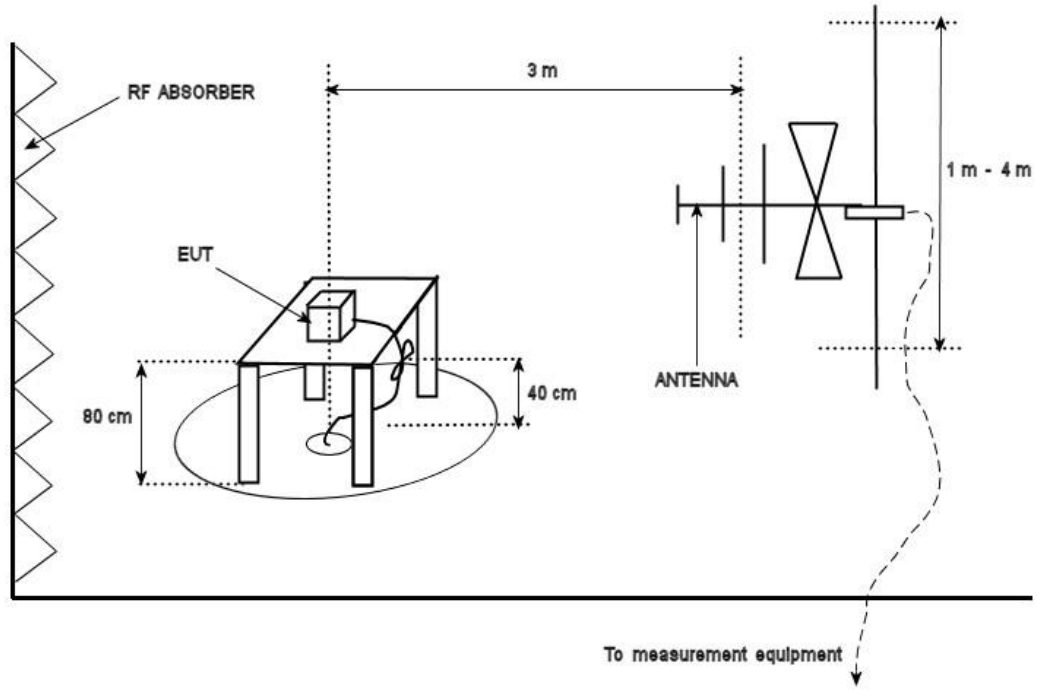
The limits, as defined in 15.247(d) for unintentional radiated emissions apply for those emissions that fall in the restricted bands, as defined in Section 15.205(a). These emissions must comply with the radiated emission limits specified in Section 15.209(a).

All unintentional emissions must also meet the 'Spurious Conducted Emissions' requirements of -20 dBc or greater. See also 'Spurious Conducted Emissions' for further details.

30 MHZ – 88 MHz, 100 uV/m (40.0 dBuV/m[1]) at 3 m
88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m[1]) at 3 m
216 MHz – 960 MHz, 200 uV/m (46.4 dBuV/m[1]) at 3 m
Above 960 MHz, 500 uV/m (54.0 dBuV/m[1]) at 3 m
Above 1000 MHz, 500 uV/m (54.0 dBuV/m[2]) at 3m

[1]Limit is with 120 kHz measurement bandwidth and a using a Quasi Peak detector.
[2]Limit is with 1 MHz measurement bandwidth and using an Average detector, scanned in accordance with 15.33 to above the 10th harmonic (10 GHz).

Typical Radiated Emissions Setup



Measurement Uncertainty

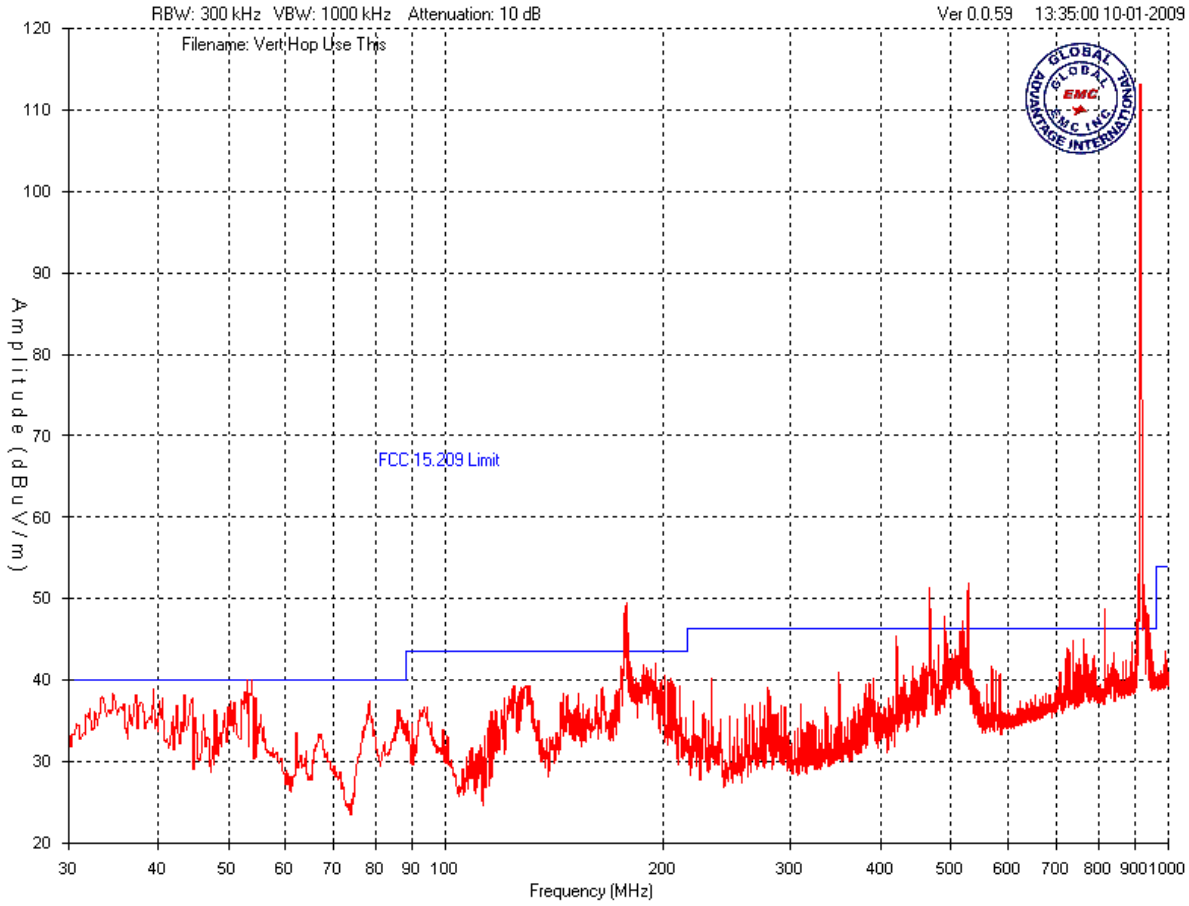
The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-4.4 dB with a 'k=2' coverage factor and a %95 confidence level.

Preliminary Graphs

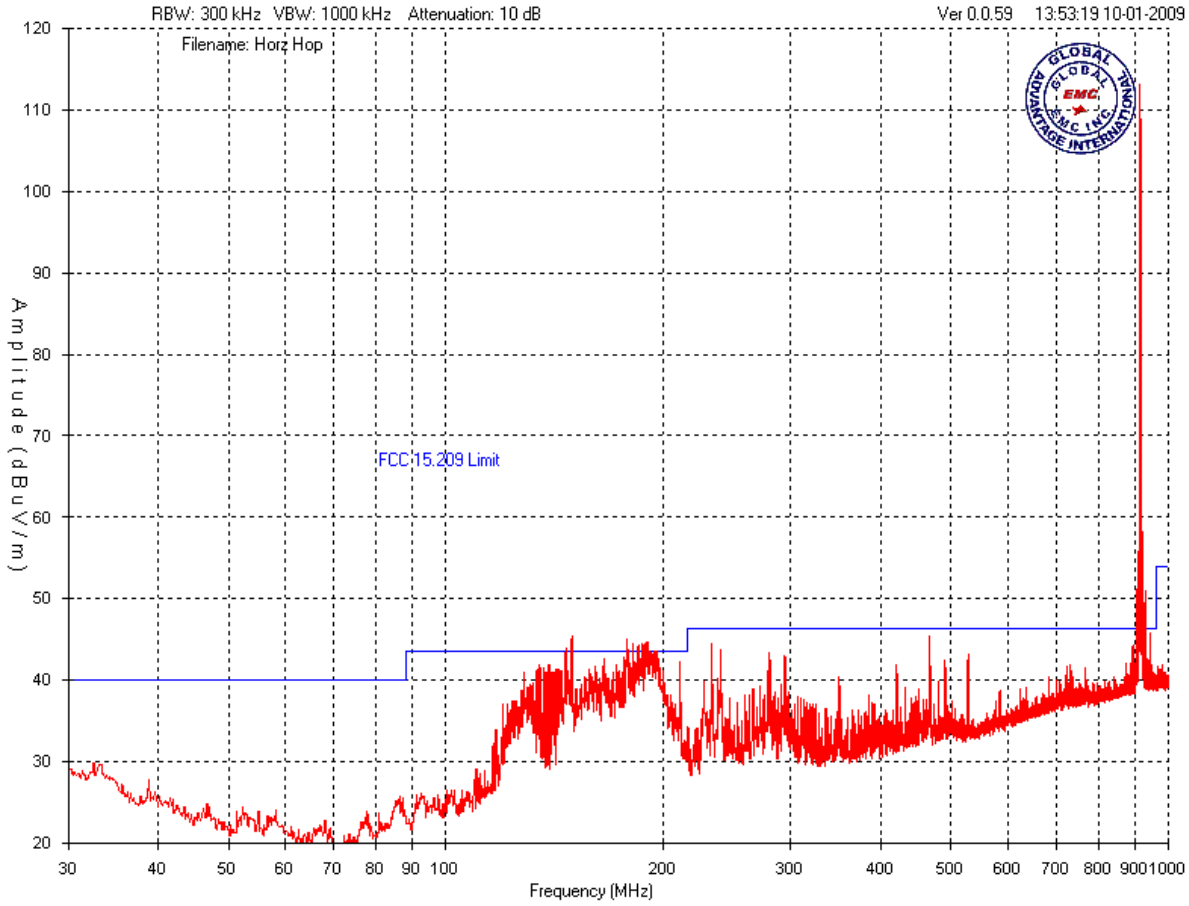
Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graph shown below is a maximized peak measurement graph, measured with a resolution bandwidth greater then the final required detector and over a full 0-360 rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.

In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to a minimum of a 10 GHz.
Note: Since the receiver has a permanently attached antenna, it was tested for 15.111 → 15.109 limits for radiated emissions. Tests were performed in listen mode to ensure no spurious emissions in 30 MHz – 1000 MHz were emitted from the unit.

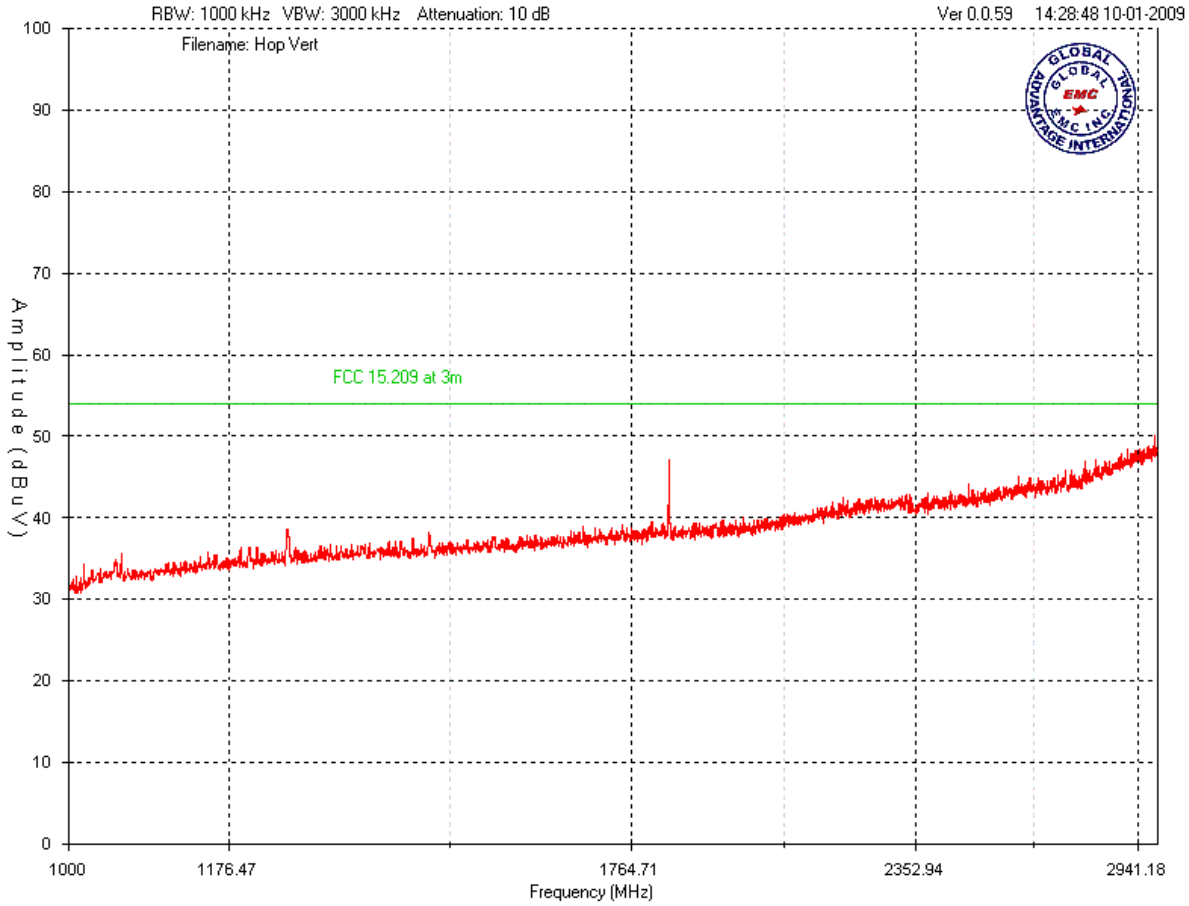
Vertical – Peak Emissions Graph – Frequency Hopping Mode
30 MHz – 1 GHz



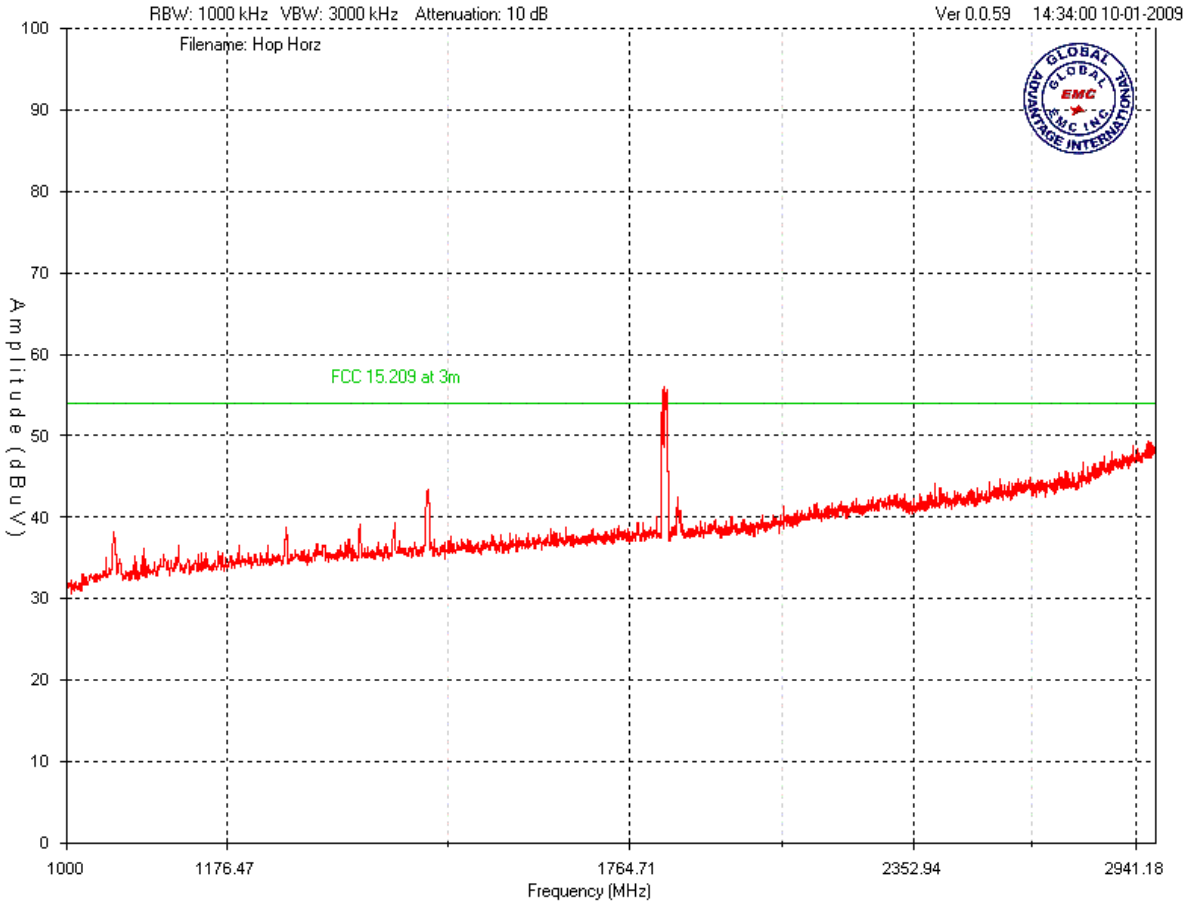
Horizontal – Peak Emissions Graph – Frequency Hopping Mode
30 MHz – 1 GHz



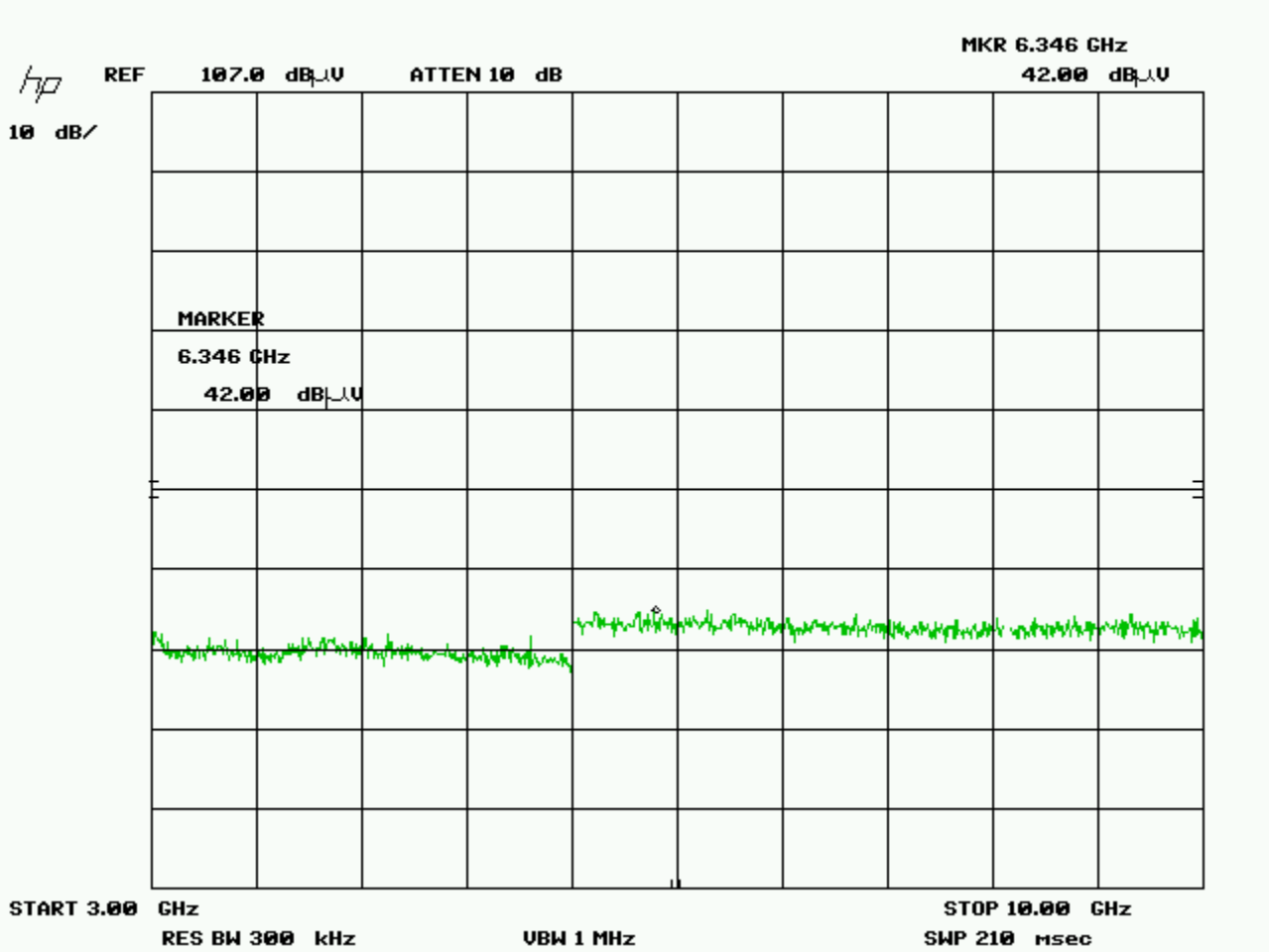
Vertical – Peak Emissions Graph – Hopping mode
1 GHz – 3 GHz



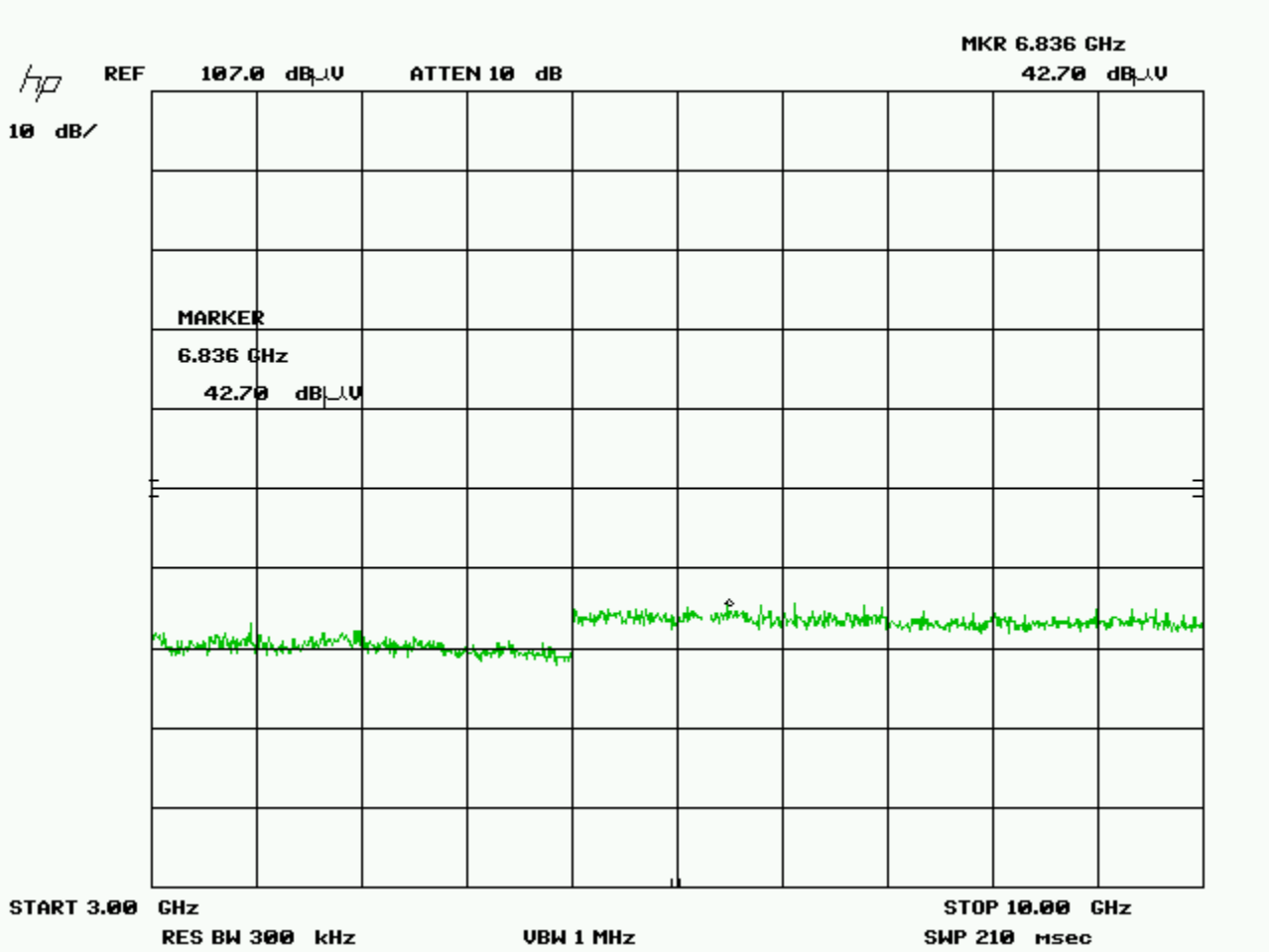
Horizontal – Peak Emissions Graph – Hopping mode
1 GHz – 3 GHz



Vertical – Peak Emissions Graph – Hop mode
3 GHz – 10 GHz



Horizontal – Peak Emissions Graph – Hop mode
3 GHz – 10 GHz



Final Measurements

Note: In accordance with 15.247(d), only radiated emissions exceeding the 15.209 limit that occur within the bands listed in 15.205, need to be verified with a quasi-peak detector or an average detector.

The requirement of -20dBc is verified by the conducted method; please see 'Spurious Antenna Conducted Emissions' section of this report.

Some of the frequency shown on the peak graph between do not fall within a restricted band as listed in FCC 15.205 and hence were not verified.

For information purposes, the fundamental was measured to be 115.8 dbuV/m at 3 meters, and none of the unintentional radiated emissions that fall outside of the restricted bands exceeded the -20dBc (or 95.8 dbuV/m) requirement.

The following measurements were made at the harmonics shown in the above graphs.

See 'Spurious Antenna Conducted Emissions' measurements for -20 dBc requirements.

Client	Lyngsoe Systems
Product	TT8350LSA
Standard(s)	RSS 210 Issue 7:2007 / FCC Part 15 Subpart C 15:2006

Radiated Emissions Measurements

Product category	Class B Group 1										
Project Name / Number	TT8350LSA										
Test Frequency (MHz)	**Detection mode (Q-Peak)**	**Antenna polarity (Horz/Vert)**	**Raw signal dB(µV)**	**Antenna factor dB**	**Cable loss dB**	**Attenuator dB**	**Pre-Amp Gain dB**	**Received signal dB(µV/m)**	**Emission limit dB(µV/m)**	**Margin dB(µV)**	**Result**
Hop Mode											
156.7	QP	Horz	36.7	8.8	1.1	10.0	32.0	24.6	43.5	18.9	PASS
200	QP	Horz	41.0	10.4	1.1	10.0	32.0	30.5	43.5	13.0	PASS
233	QP	Horz	35.0	11.6	1.1	10.0	32.0	25.7	46.0	20.3	PASS
467	QP	Horz	29.0	17.3	1.1	10.0	32.0	25.4	46.0	20.6	PASS
144	QP	Horz	50.8	7.9	1.1	10.0	32.0	37.8	43.5	5.7	PASS
240	QP	Horz	45.0	11.6	1.1	10.0	32.0	35.7	46.0	10.3	PASS
153	QP	Vert	31.0	8.9	1.1	10.0	32.0	19.0	43.5	24.5	PASS
201	QP	Vert	31.6	10.4	1.1	10.0	32.0	21.1	43.5	22.4	PASS
91	QP	Vert	32.0	8.4	0.9	10.0	32.0	19.3	43.5	24.2	PASS
42	QP	Vert	29.1	10.9	0.9	10.0	32.0	18.9	40.0	21.1	PASS
56	QP	Vert	31.0	8.3	0.9	10.0	32.0	18.2	40.0	21.8	PASS
467	QP	Vert	40.0	16.6	1.1	10.0	32.0	35.7	46.0	10.3	PASS

Client	Lyngsoe Systems
Product	TT8350LSA
Standard(s)	RSS 210 Issue 7:2007 / FCC Part 15 Subpart C 15:2006

528	QP	Vert	41.1	18.1	1.3	10.0	31.0	39.5	46.0	6.5	PASS
177.8	QP	Vert	36.2	10.0	1.1	10.0	32.0	25.3	43.5	18.2	PASS
55.8	QP	Vert	31.0	8.3	0.9	10.0	32.0	18.2	40.0	21.8	PASS
144	QP	Vert	45.5	8.0	1.1	10.0	32.0	32.6	43.5	10.9	PASS
1830	Peak	Vert	55.1	27.3	2.4	0.0	36.0	48.8	74.0	25.2	PASS
1830	Avg	Vert	45.1	27.3	2.4	0.0	36.0	38.8	54.0	15.2	PASS
1826	Peak	Horz	63.5	29.0	2.4	0.0	36.0	58.9	74.0	15.1	PASS
1825	Avg	Horz	55.2	29.0	2.4	0.0	36.0	50.6	54.0	3.4	PASS
913	Peak	Vert	112.0	22.5	1.6	10.0	31.0	115.1			PASS
913	Avg	Vert	111.3	22.5	1.6	10.0	31.0	114.4			PASS
912.5	Peak	Horz	107.1	23.7	1.6	10.0	31.0	111.4			PASS
912.5	Avg	Horz	106.5	23.7	1.6	10.0	31.0	110.8			PASS
Low Channel											
467	QP	Vert	39.7	16.6	1.1	10.0	32.0	35.4	46.0	10.6	PASS
528	QP	Vert	45.4	18.1	1.3	10.0	31.0	43.8	46.0	2.2	PASS
490	QP	Vert	47.0	17.9	1.1	10.0	32.0	44.0	46.0	2.0	PASS
1824	Peak	Vert	54.2	27.3	2.4	0.0	36.0	47.9	74.0	26.1	PASS
1824	Avg	Vert	50.0	27.3	2.4	0.0	36.0	43.7	54.0	10.3	PASS
1824	Peak	Horz	59.5	29.0	2.4	0.0	36.0	54.9	74.0	19.1	PASS
1824	Avg	Horz	57.0	29.0	2.4	0.0	36.0	52.4	54.0	1.6	PASS
912	Peak	Vert	112.7	22.5	1.6	10.0	31.0	115.8			PASS

Client	Lyngsoe Systems
Product	TT8350LSA
Standard(s)	RSS 210 Issue 7:2007 / FCC Part 15 Subpart C 15:2006

912	Avg	Vert	111.6	22.5	1.6	10.0	31.0	114.7			PASS
912	Peak	Horz	107.0	23.7	1.6	10.0	31.0	111.3			PASS
912	Avg	Horz	106.5	23.7	1.6	10.0	31.0	110.8			PASS
Mid Channel											
1830	Peak	Vert	52.5	27.3	2.4	0.0	36.0	46.2	74.0	27.8	PASS
1830	Avg	Vert	48.2	27.3	2.4	0.0	36.0	41.9	54.0	12.1	PASS
1830	Peak	Horz	58.5	29.0	2.4	0.0	36.0	53.9	74.0	20.1	PASS
1830	Avg	Horz	56.5	29.0	2.4	0.0	36.0	51.9	54.0	2.1	PASS
915	Peak	Vert	112.3	22.5	1.6	10.0	31.0	115.4			PASS
915	Avg	Vert	111.5	22.5	1.6	10.0	31.0	114.6			PASS
915	Peak	Horz	106.5	23.7	1.6	10.0	31.0	110.8			PASS
915	Avg	Horz	104.7	23.7	1.6	10.0	31.0	109.0			PASS
Hi Channel											
1834	Peak	Vert	52.1	27.3	2.4	0.0	36.0	45.8	74.0	28.2	PASS
1834	Avg	Vert	48.3	27.3	2.4	0.0	36.0	42.0	54.0	12.0	PASS
1834	Peak	Horz	58.6	29.0	2.4	0.0	36.0	54.0	74.0	20.0	PASS
1834	Avg	Horz	57.0	29.0	2.4	0.0	36.0	52.4	54.0	1.6	PASS
917	Peak	Vert	112.1	22.5	1.6	10.0	31.0	115.2			PASS
917	Avg	Vert	111.8	22.5	1.6	10.0	31.0	114.9			PASS
917	Peak	Horz	105.7	23.7	1.6	10.0	31.0	110.0			PASS
917	Avg	Horz	104.4	23.7	1.6	10.0	31.0	108.7			PASS

Note: No emissions above the 2nd harmonic were detected.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2008-02-28	2010-02-28	GEMC 6
Quasi Peak Adapter	85650A	HP	2008-02-28	2010-02-28	GEMC 7
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	GEMC 40
Pre-Amplifier	PA-2.5-26	Vican	8/26/2008	8/26/2010	GEMC 9
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31
Attenuator 6 dB	FP-50-6	Trilithic	NCR	NCR	GEMC 41
Attenuator 10 dB	FP-50-10	Trilithic	NCR	NCR	GEMC 42
Attenuator 20 dB	FP-50-20	Trilithic	NCR	NCR	GEMC 43

This report module is based on GEMC template "FCC - 15.209 - Radiated Emissions_Rev2.doc"

Channel Carrier Separation for Frequency Hopping Systems

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information.

Limits

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1)

	902 to 928 MHz	2.4 to 2.4835 GHz	5.275 to 5.85 GHz
No conditions	25 kHz or 20 dB BW[1]	25 kHz or 20 dB BW[1]	25 kHz or 20 dB BW[1]
< 125 mW	25 kHz or 20 dB BW[1]	25 kHz or 2/3 of 20 dB BW[1]	25 kHz or 20 dB BW[1]

Note 1: Whichever is greater. The 20 dB BW of the system was measured to be 96.9 kHz, so a limit of 96.9 kHz applies.

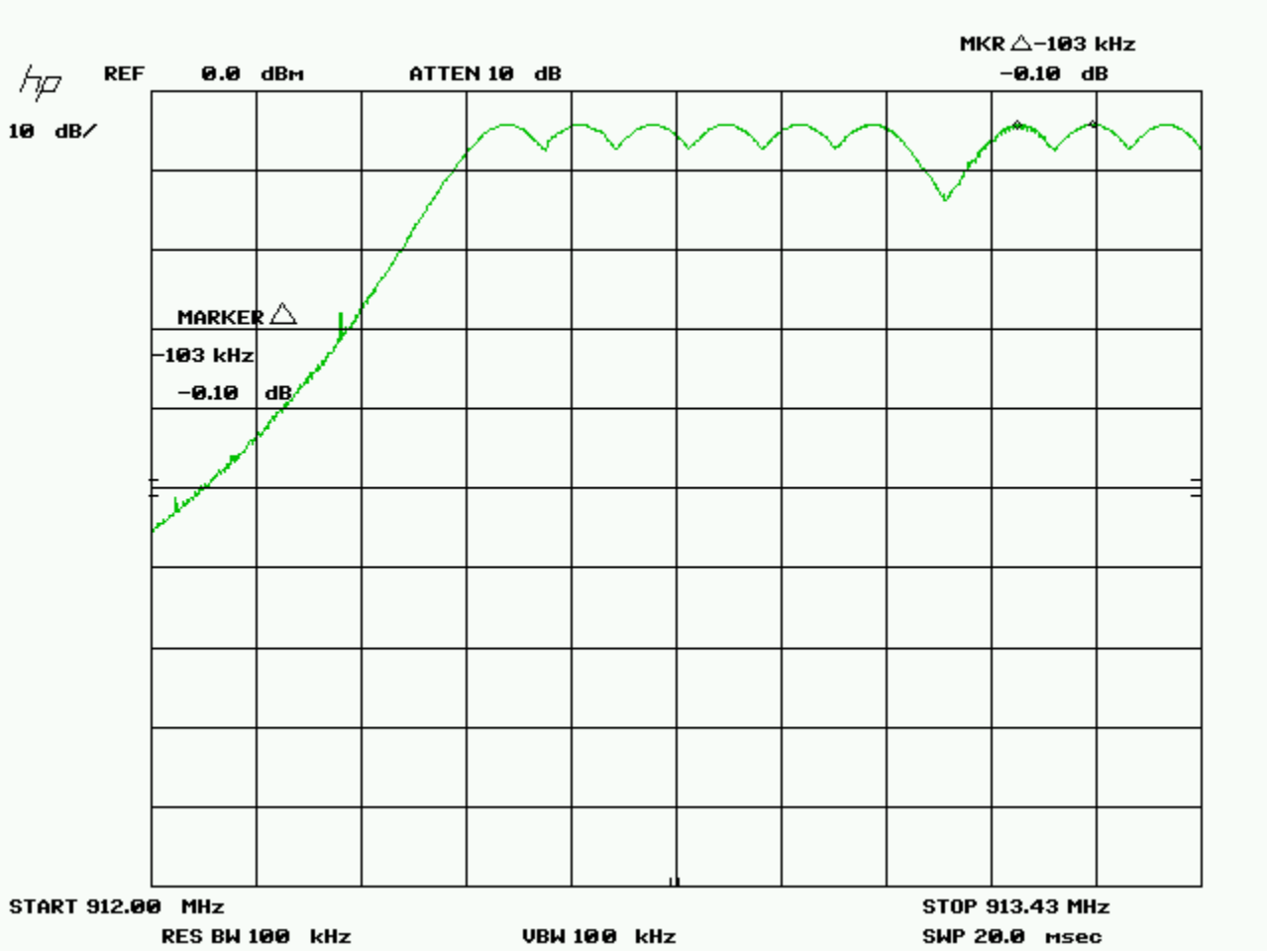
Results

The EUT passed the requirements of channel carrier spacing exceeding the measured 20 dB BW of the EUT. The 20 dB BW previously measured was 96.9 kHz, and the device had a channel spacing of 103 kHz.

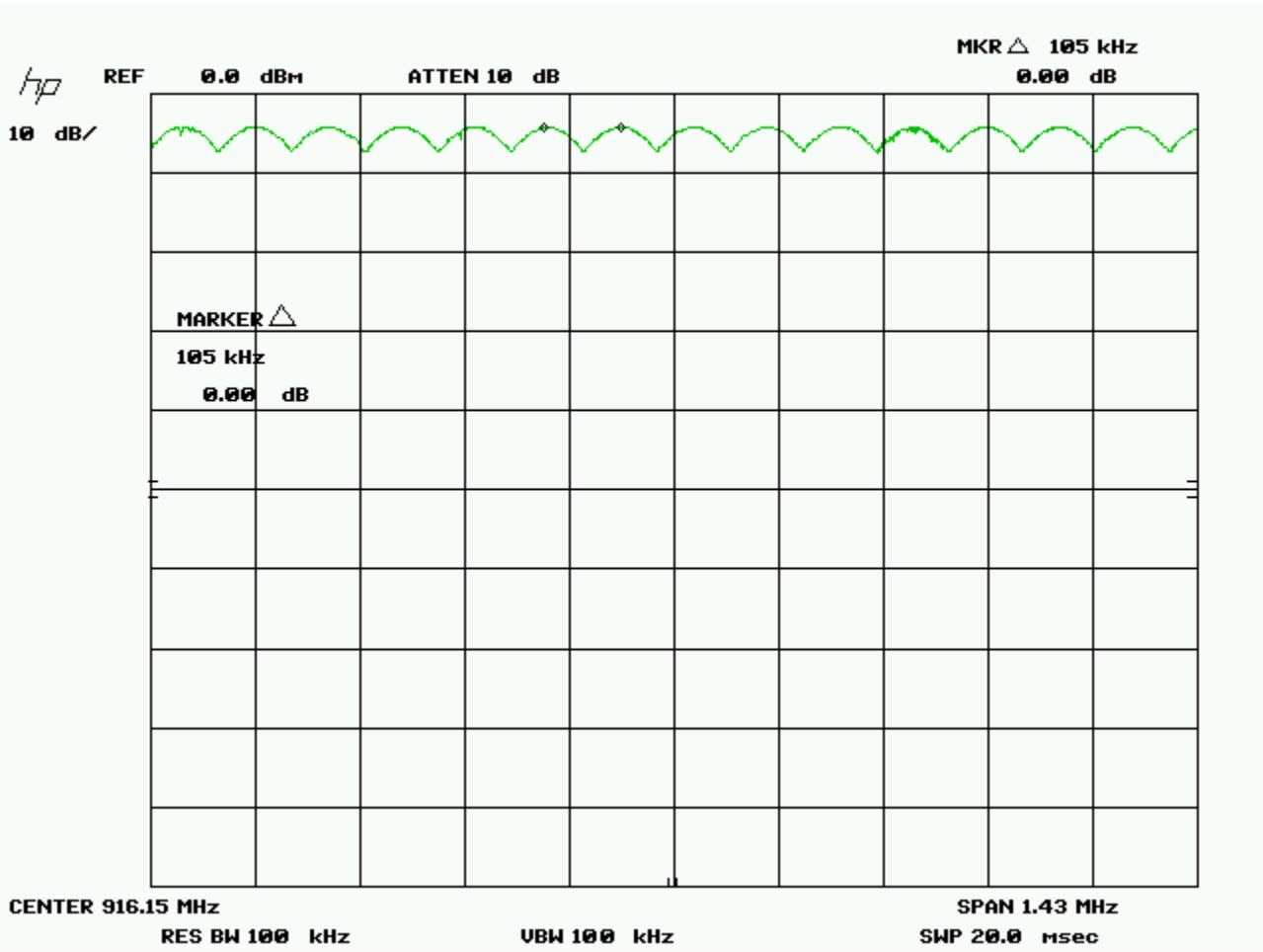
Graph(s)

The graphs below show the channel spacing during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the channel spacing of the signal being measured. This measurement is a peak measurement.

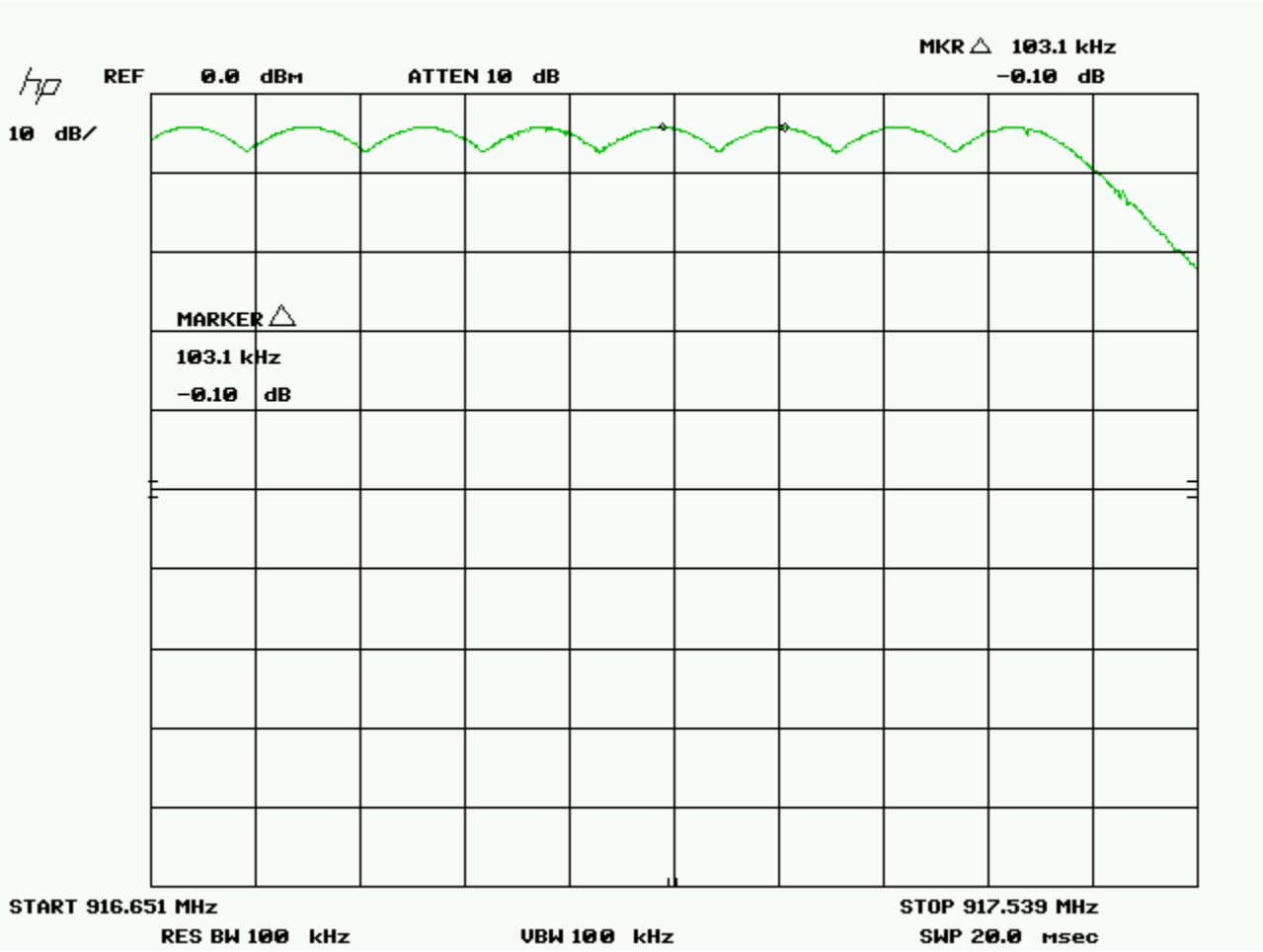
Low Channel



Mid Channel



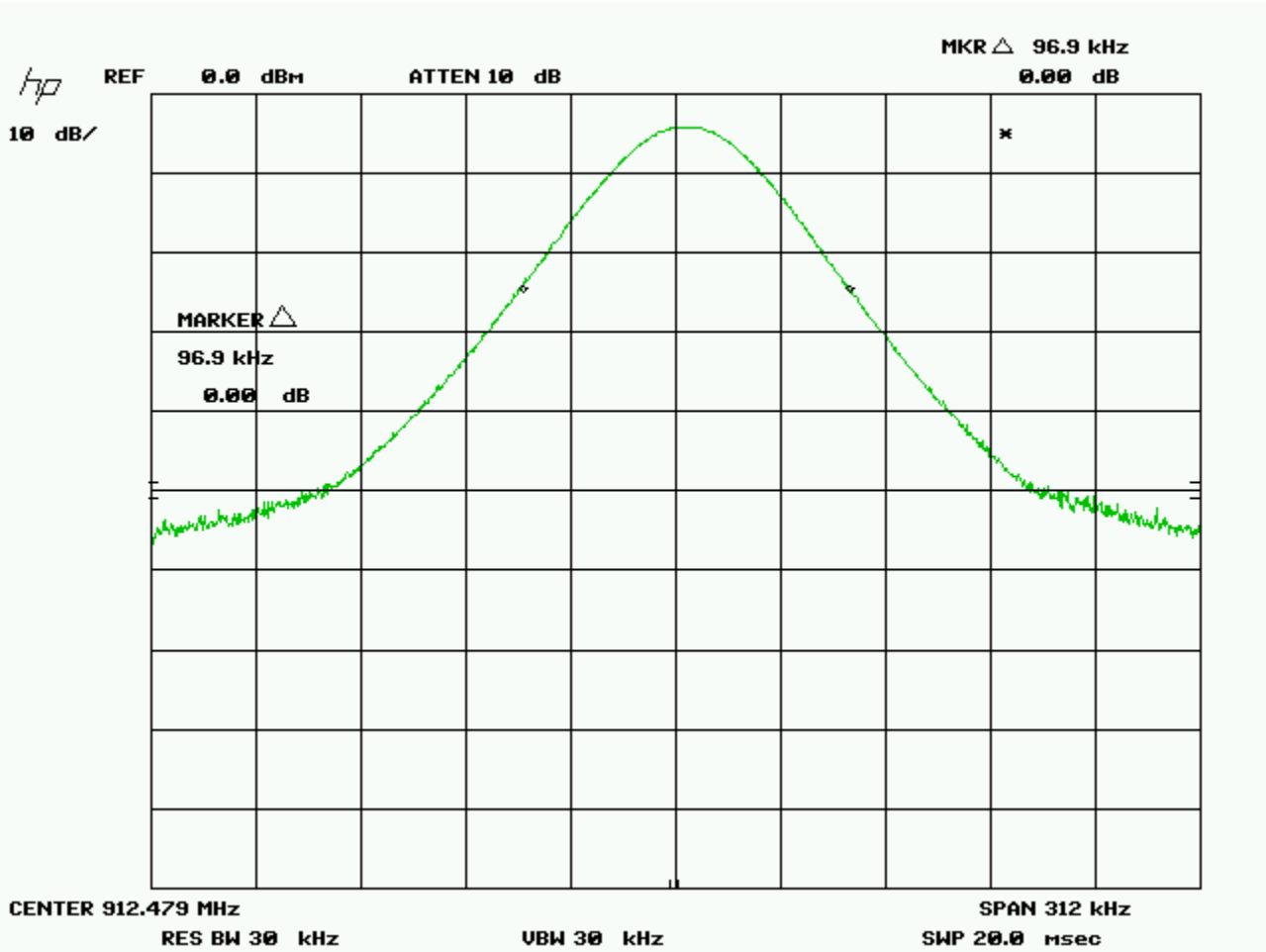
High Channel



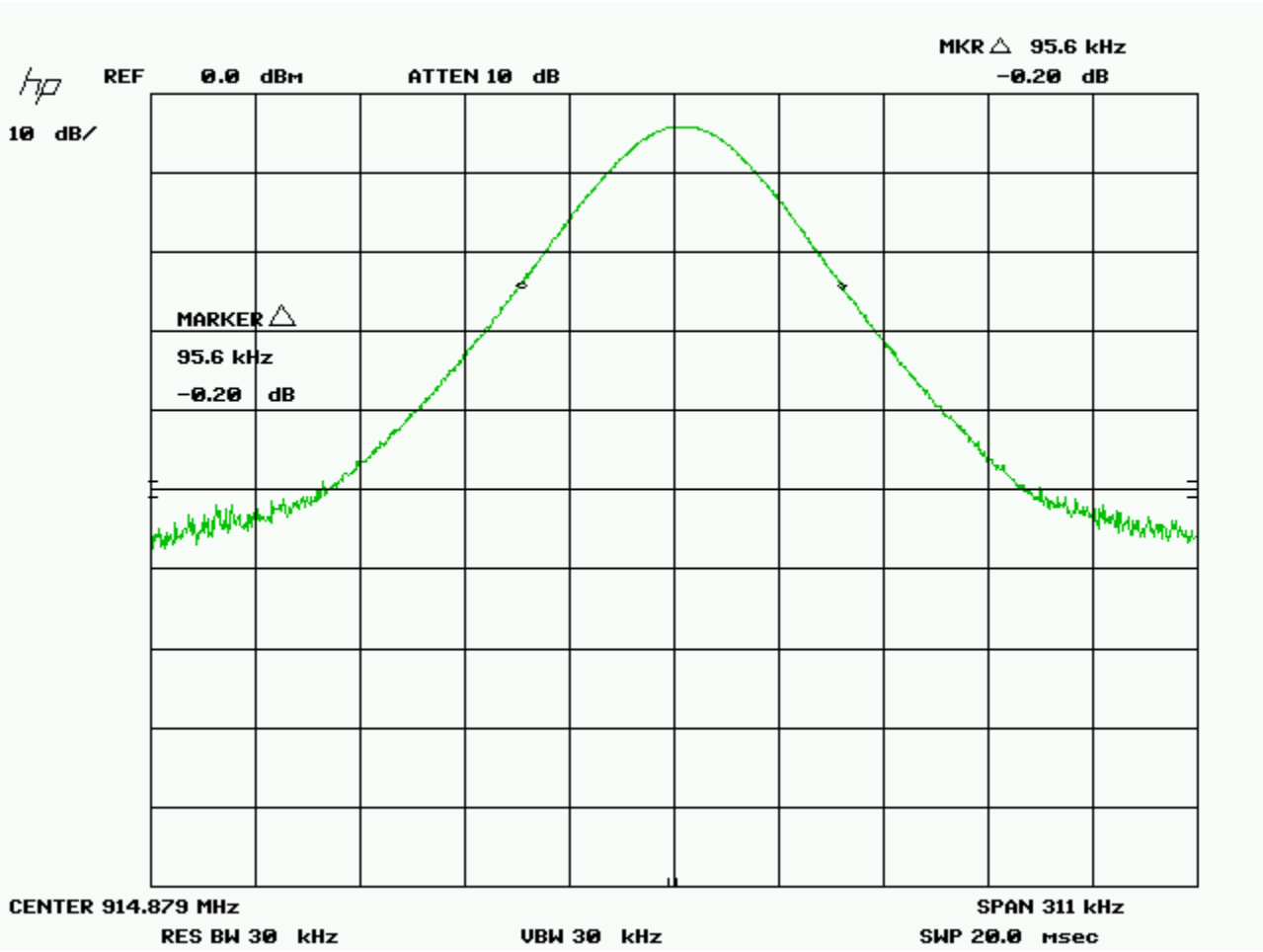
Note:

1. See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.
2. A plot of 20db BW is also attached below. This is to illustrate the measured 20 db BW at Low, Medium and High channels.

20 db BW Low channel



20 db BW Medium channel



20 db BW High channel

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2008-02-28	2010-02-28	GEMC 6
Quasi Peak Adapter	85650A	HP	2008-02-28	2010-02-28	GEMC 7
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	GEMC 40
Pre-Amplifier	PA-2.5-26	Vican	8/26/2008	8/26/2010	GEMC 9
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31
Attenuator 6 dB	FP-50-6	Trilithic	NCR	NCR	GEMC 41
Attenuator 10 dB	FP-50-10	Trilithic	NCR	NCR	GEMC 42
Attenuator 20 dB	FP-50-20	Trilithic	NCR	NCR	GEMC 43

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Number of Channels for Frequency Hopping Systems

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information.

Limits

The limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1)

	902 to 928 MHz	2.4 to 2.4835 GHz	5.275 to 5.85 GHz
No conditions	>= 50 channels	>= 15 channels	>= 75 channels
20 dB BW exceeds 250 kHz	>= 25 channels	>= 15 channels	>= 75 channels

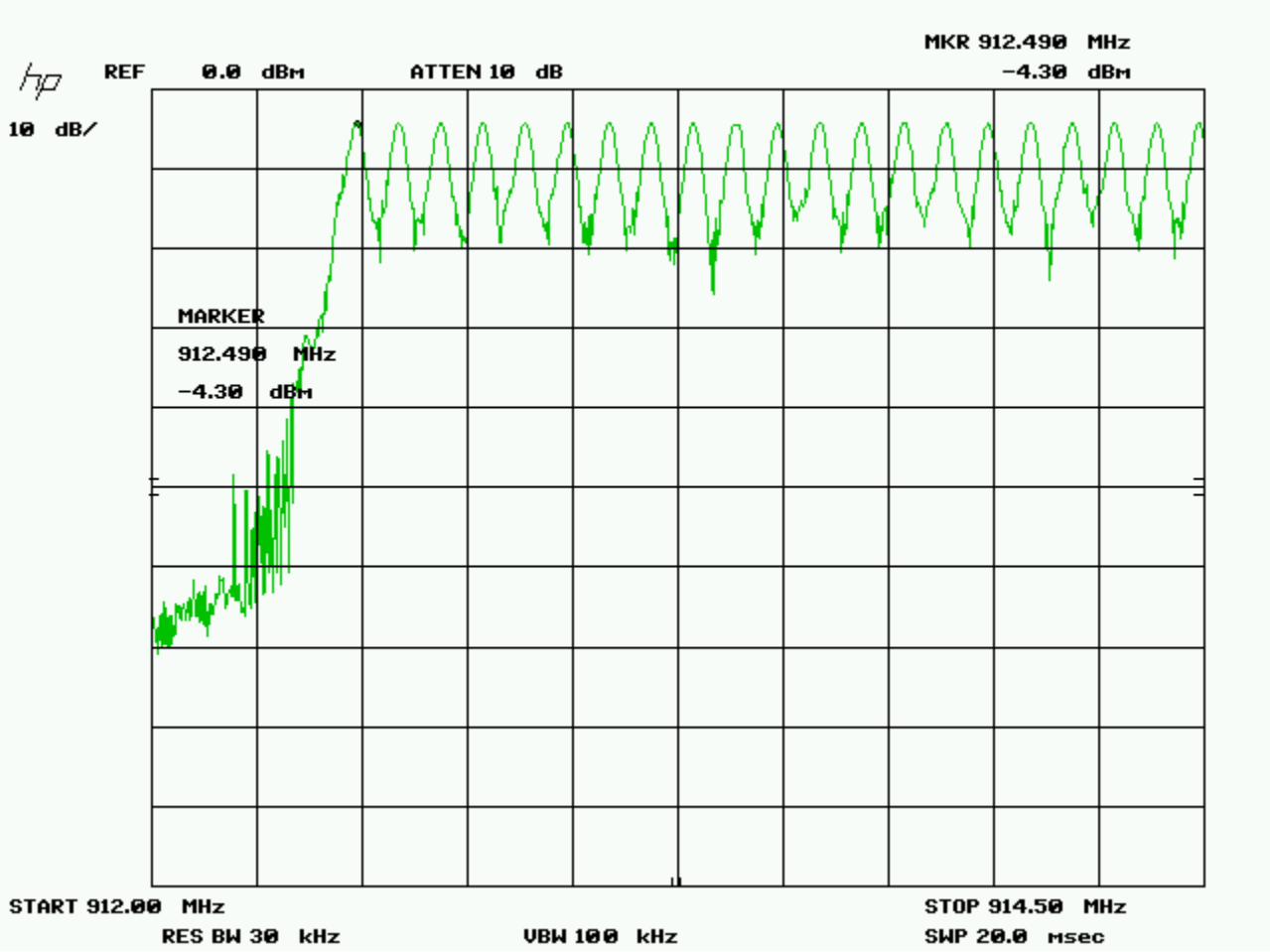
Results

Since the 20db BW of the unit does not exceed 250 kHz, the channel requirement is a minimum of 50 channels. The EUT passed the requirements of the number of channels. The number of channels the device occupies is 50 in the allocation band of 902 to 928 MHz.

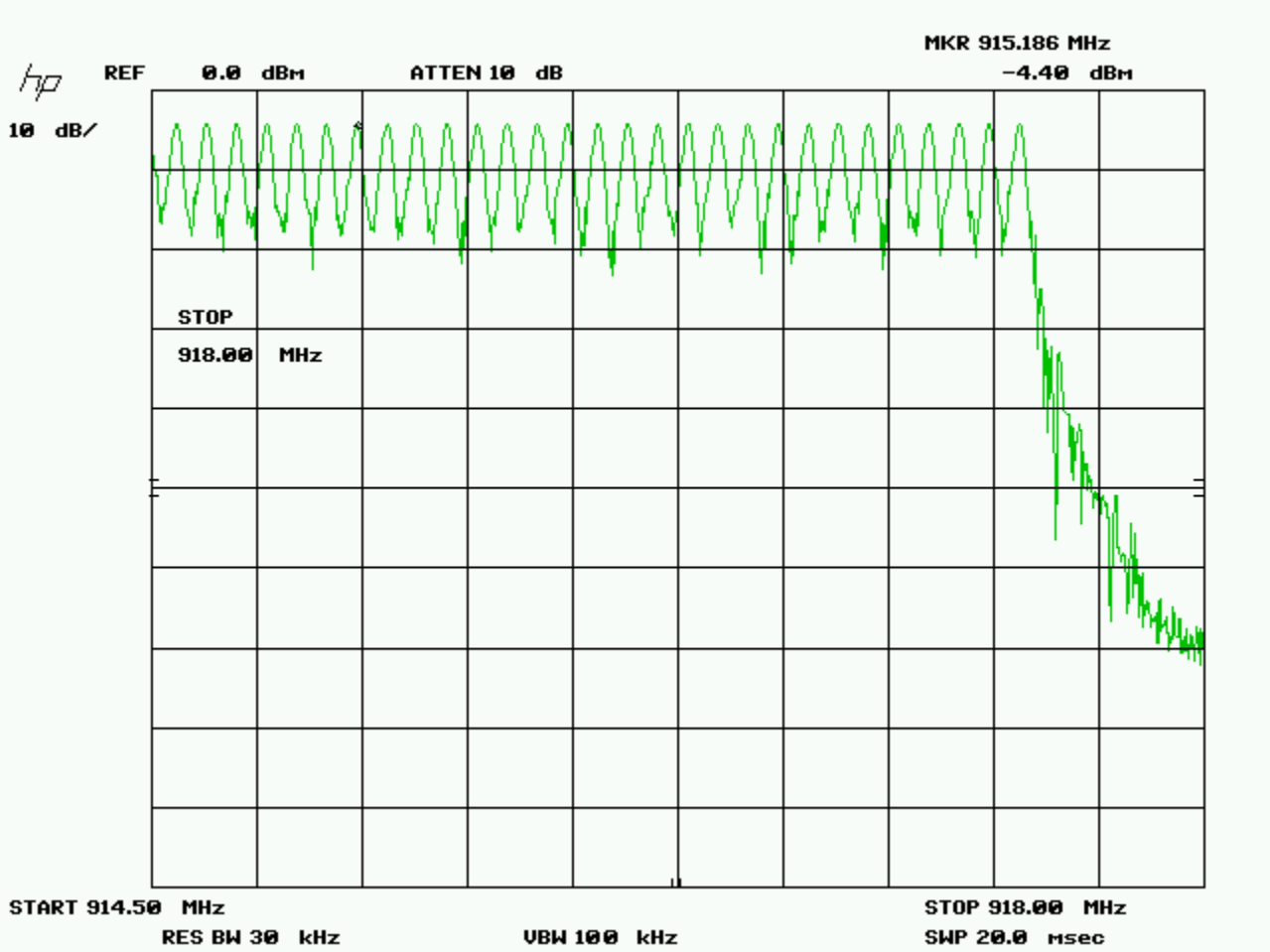
Graph(s)

The graph shown below shows the number of occupied channels during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the channel spacing of the signal being measured. This measurement is a peak measurement.

Low End



Hi End



Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2008-02-28	2010-02-28	GEMC 6
Quasi Peak Adapter	85650A	HP	2008-02-28	2010-02-28	GEMC 7
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	GEMC 40
Pre-Amplifier	PA-2.5-26	Vican	8/26/2008	8/26/2010	GEMC 9
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31
Attenuator 6 dB	FP-50-6	Trilithic	NCR	NCR	GEMC 41
Attenuator 10 dB	FP-50-10	Trilithic	NCR	NCR	GEMC 42
Attenuator 20 dB	FP-50-20	Trilithic	NCR	NCR	GEMC 43

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Frequency Occupancy for Frequency Hopping Systems

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is hopping at a minimum defined rate. This helps ensure sufficient time off to enable other frequency hopping devices to co-operate within this allocated band.

Limits

For 902 to 928 MHz systems, the limits are as defined in 47 CFR FCC Part 15 Section 15.247(a)(1)(i).

For systems with a 20 db BW less than 250 kHz the minimum number of hopping channels is 50, such as this device, the maximum time of occupancy on any channel in a 20 second period should not exceed 400ms.

Results

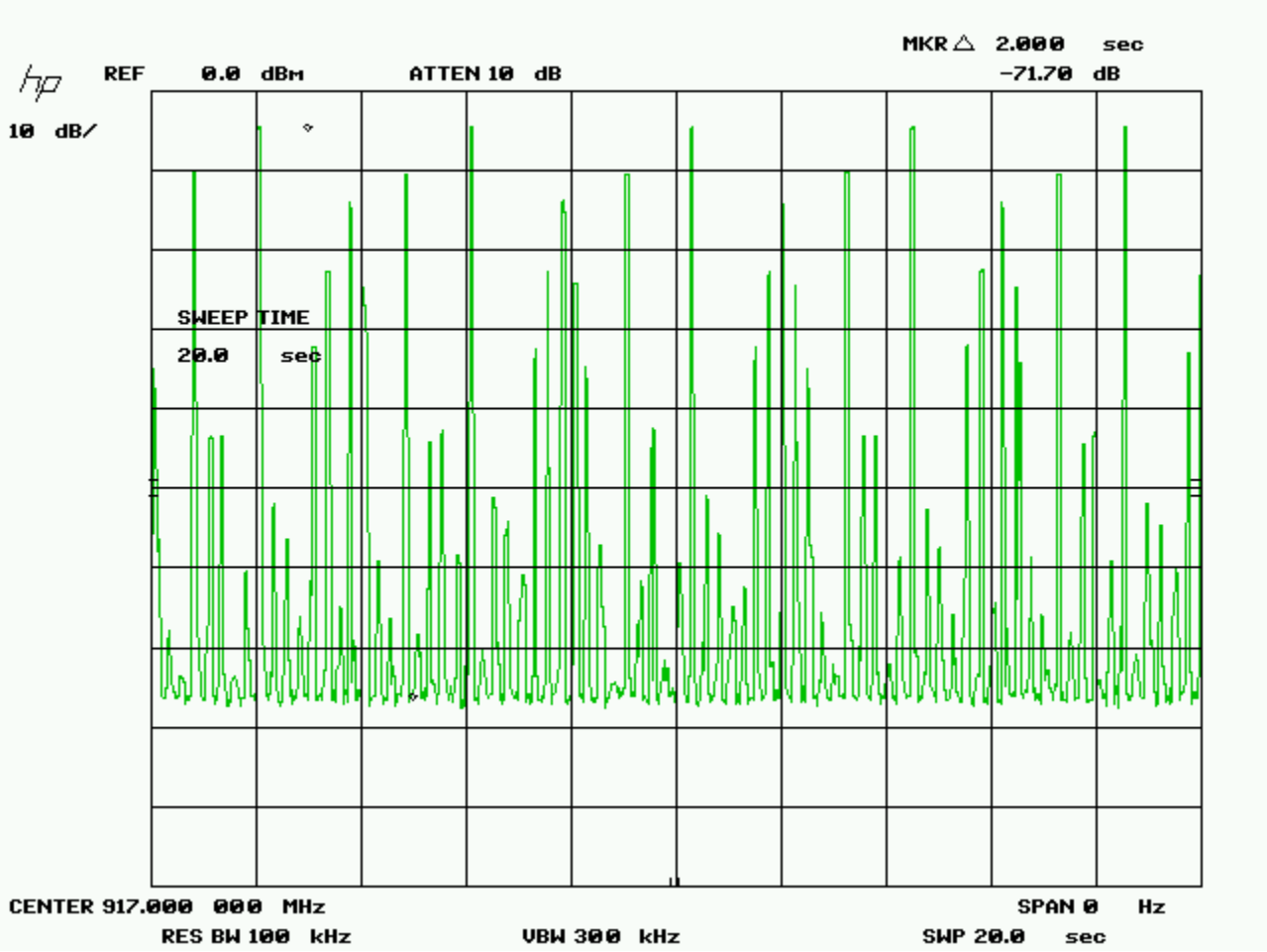
The EUT passed the requirements. The EUT cycles through its pseudo-random generated list of hopping frequencies every 4.2s. The on time duration of each hop is 40.0 msec.

Number of channels	50
Time of occupancy on each channel (ms)	40.0
Time to cycle through all channels (s)	4.2
Number of complete cycles in 20s period	5
Total on time in 20s period (ms) for a frequency	200.0

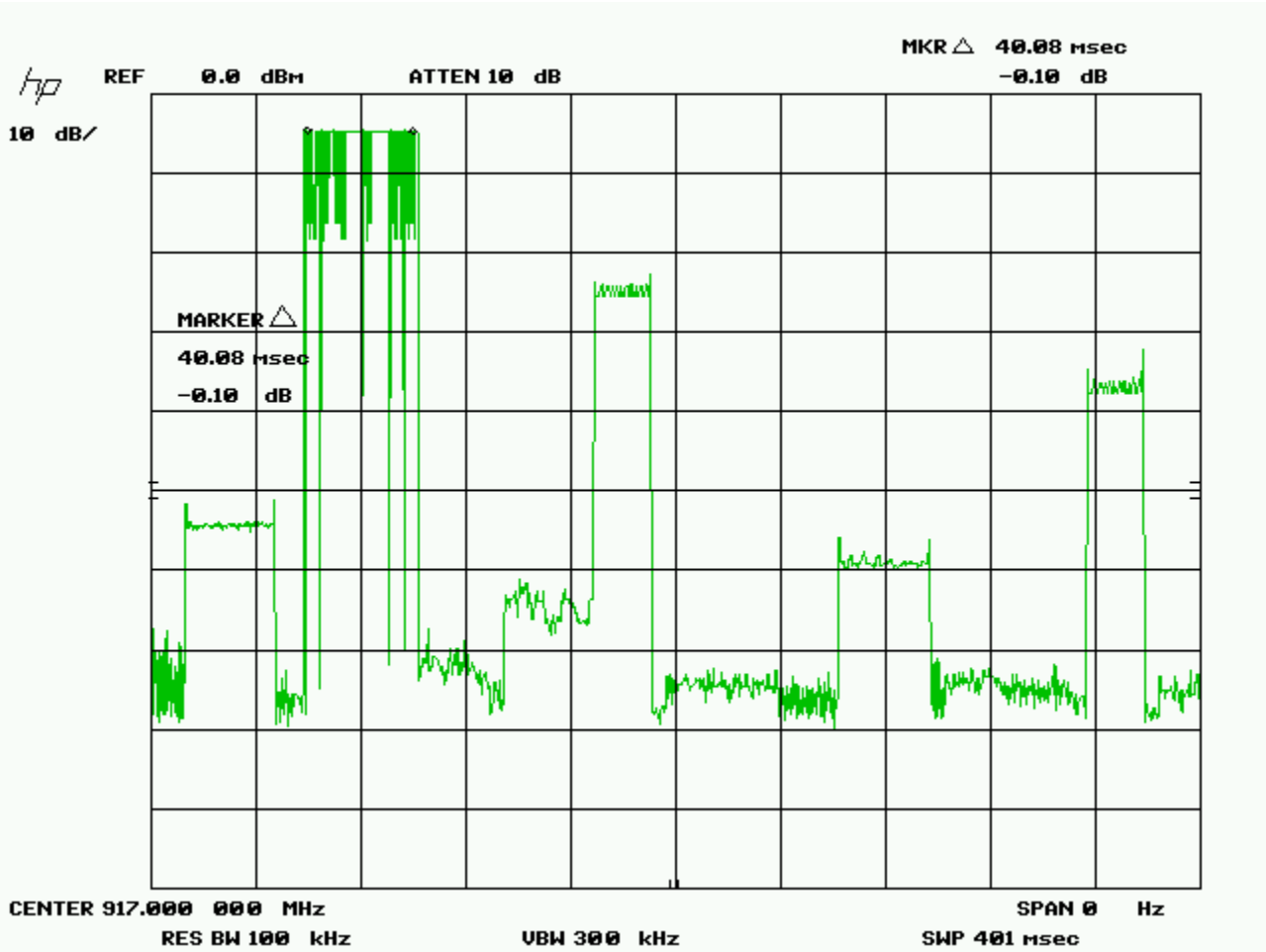
Graph(s)

The first graph shown below shows the repeat time of the pseudorandom generated hopping list. This graph was taken over a period of 10 seconds. Note that in the first graph, the peak represents the 'on' of the frequency being measured. The lower signals are artifacts of nearby channels due to the wide resolution BW used.

Hopping List repeat rate



On time during each channel



Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2008-02-28	2010-02-28	GEMC 6
Quasi Peak Adapter	85650A	HP	2008-02-28	2010-02-28	GEMC 7
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	GEMC 40
Pre-Amplifier	PA-2.5-26	Vican	8/26/2008	8/26/2010	GEMC 9
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31
Attenuator 6 dB	FP-50-6	Trilithic	NCR	NCR	GEMC 41
Attenuator 10 dB	FP-50-10	Trilithic	NCR	NCR	GEMC 42
Attenuator 20 dB	FP-50-20	Trilithic	NCR	NCR	GEMC 43

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Maximum Peak Envelope Conducted Power

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified.

Limits

The limits are defined in 15.247(b).
For frequency hopping systems operating in the 902-928 MHz band employing at least 50 hopping channels, the peak limit is 1 watt.

Results

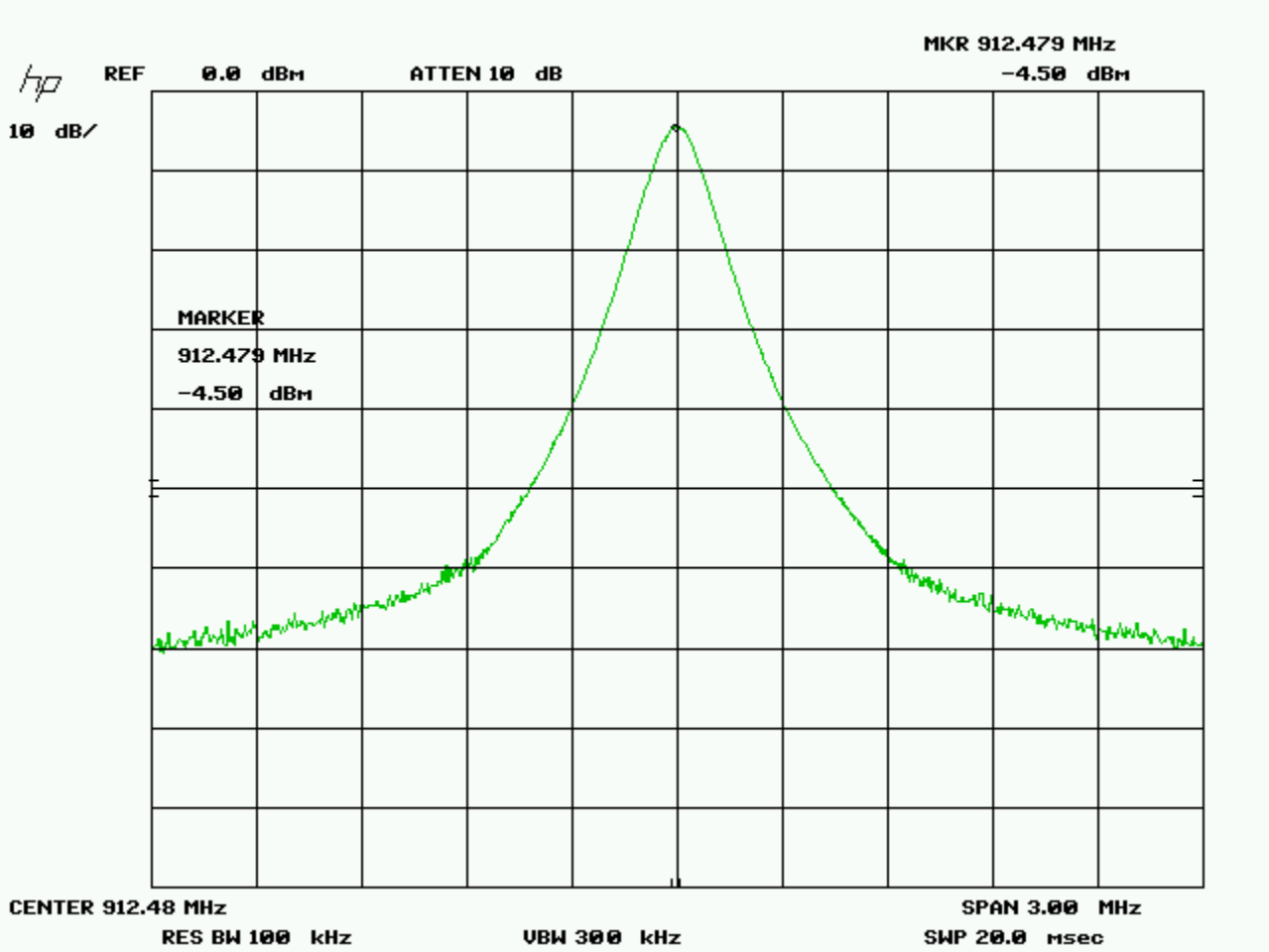
The EUT passed. The peak power measured was 15.8 dbm (38.0 mW)

Graph(s)

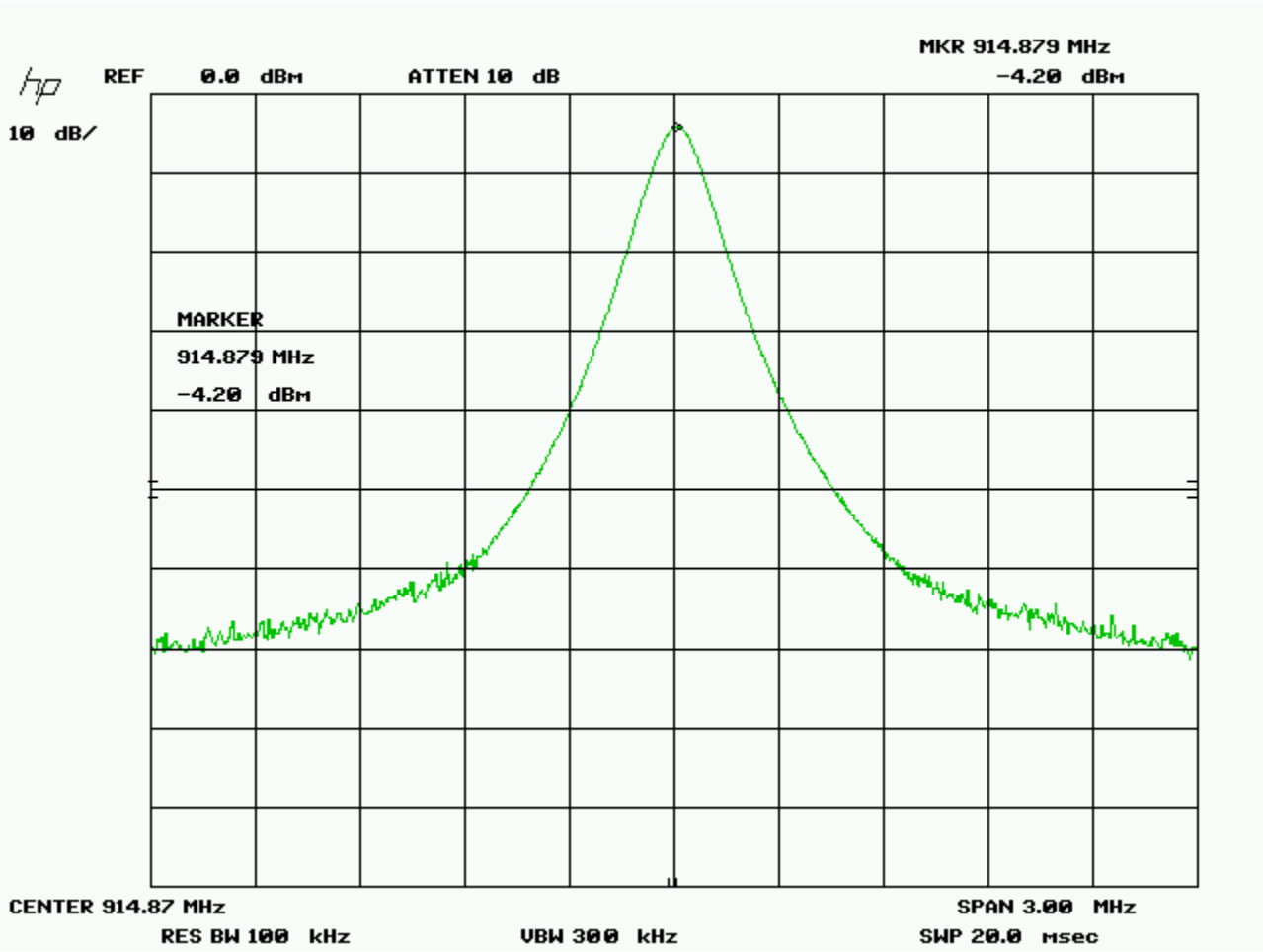
The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT. Note there was 20 dB of external attenuation taken during this measurement.

The calculated value is:
-4.2 dBm + 20 dB (attenuator) = 15.8 dbm

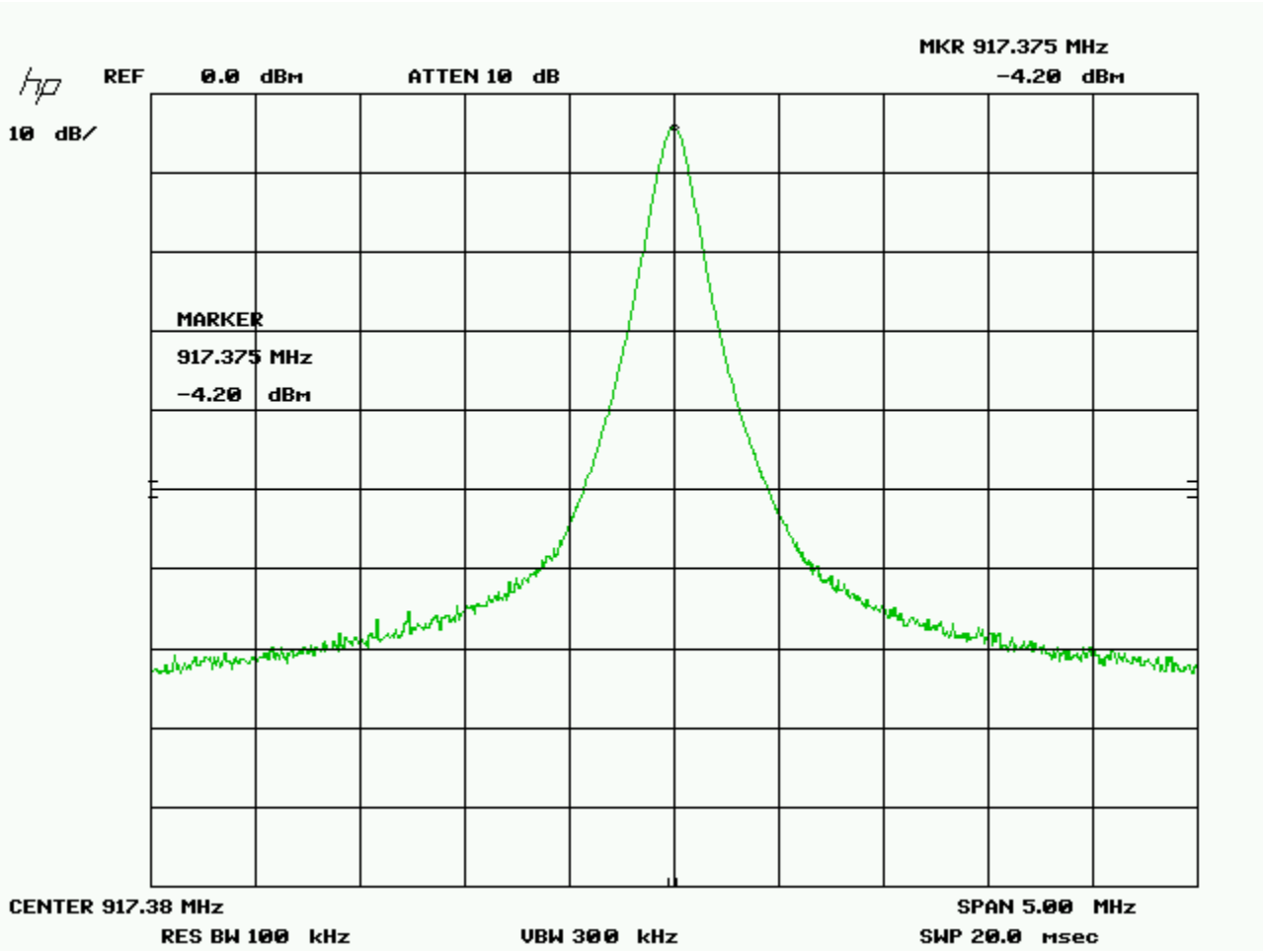
Low channel



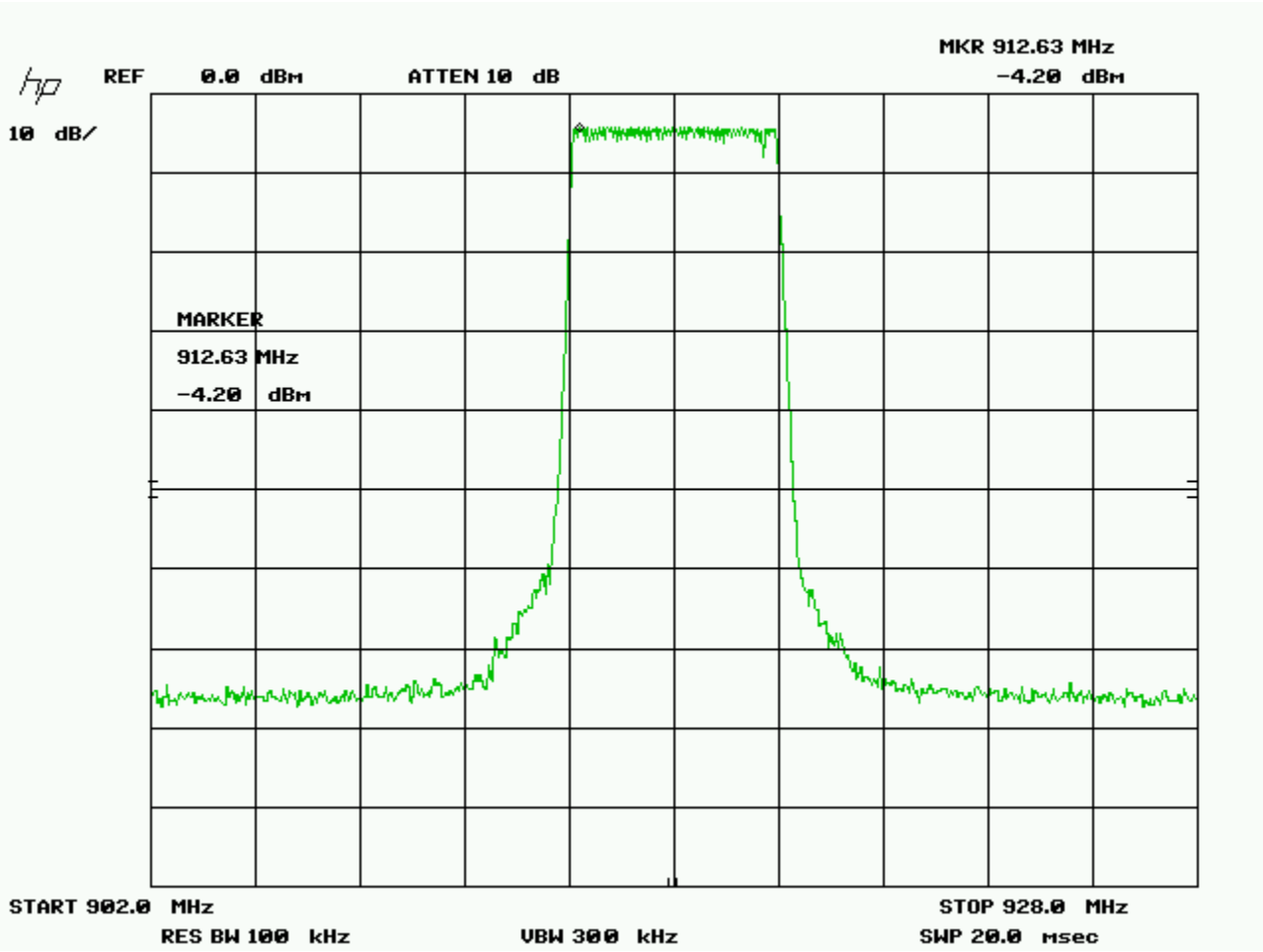
Medium channel



High channel



Hopping On



Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2008-02-28	2010-02-28	GEMC 6
Quasi Peak Adapter	85650A	HP	2008-02-28	2010-02-28	GEMC 7
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	GEMC 40
Pre-Amplifier	PA-2.5-26	Vican	8/26/2008	8/26/2010	GEMC 9
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31
Attenuator 6 dB	FP-50-6	Trilithic	NCR	NCR	GEMC 41
Attenuator 10 dB	FP-50-10	Trilithic	NCR	NCR	GEMC 42
Attenuator 20 dB	FP-50-20	Trilithic	NCR	NCR	GEMC 43

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Spurious Emissions -20 dbc Rule

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified.

Limits

The limits are defined in 15.247(d).
In any 100 kHz band, the peak spurious harmonics emissions must be at least 20 dB below the fundamental.

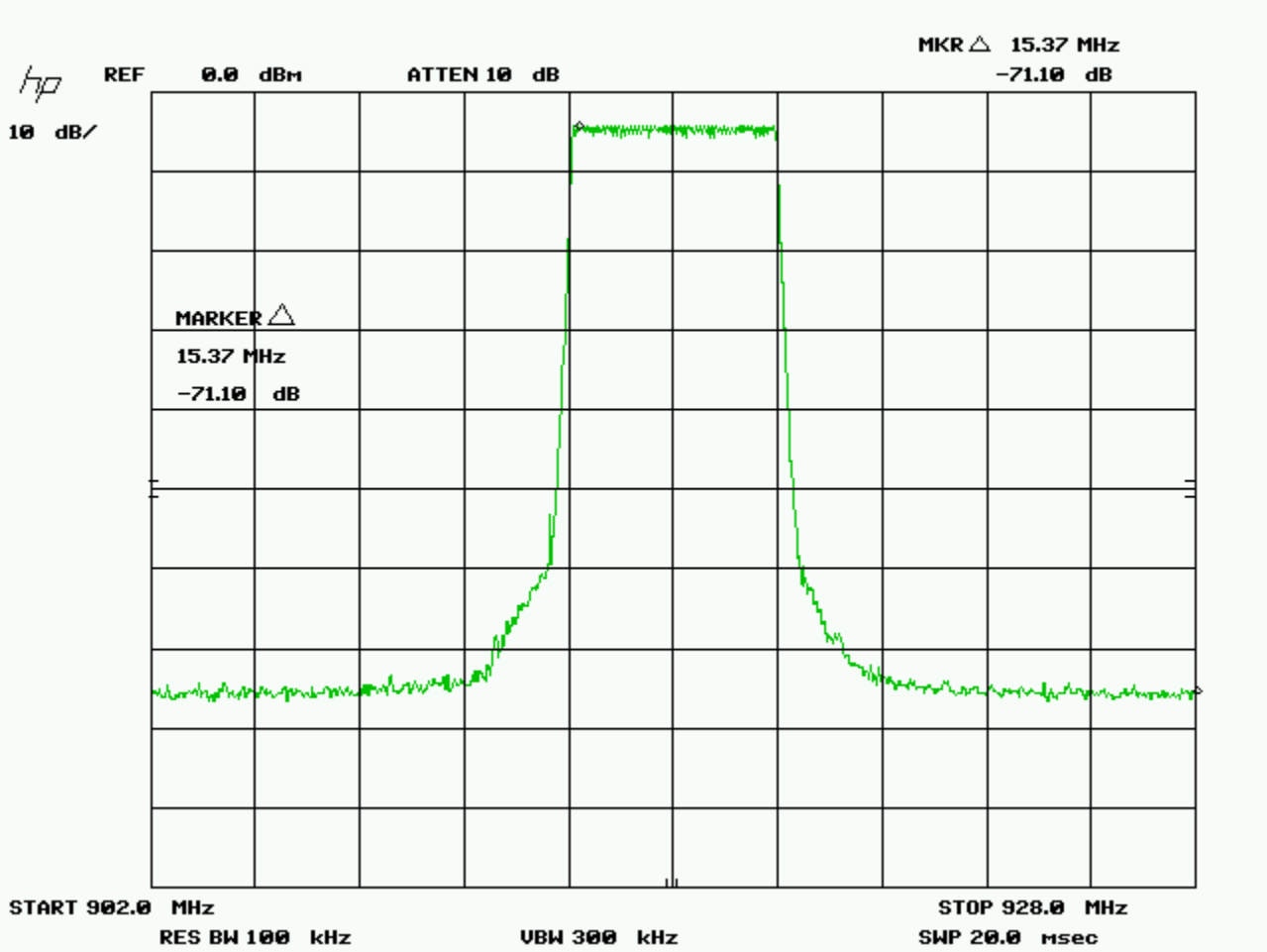
Results

The EUT passed. The peak power measured was 15.8 dbm (38.0 mW). The worst case reading was the hoping mode 9 kHz – 2 GHz plot. Since the peak was measured at -4.8 dbm (with 20 db attenuator) there is a – 61.7 dbc under this configuration. This is well within the limits of -20 dbc rule.

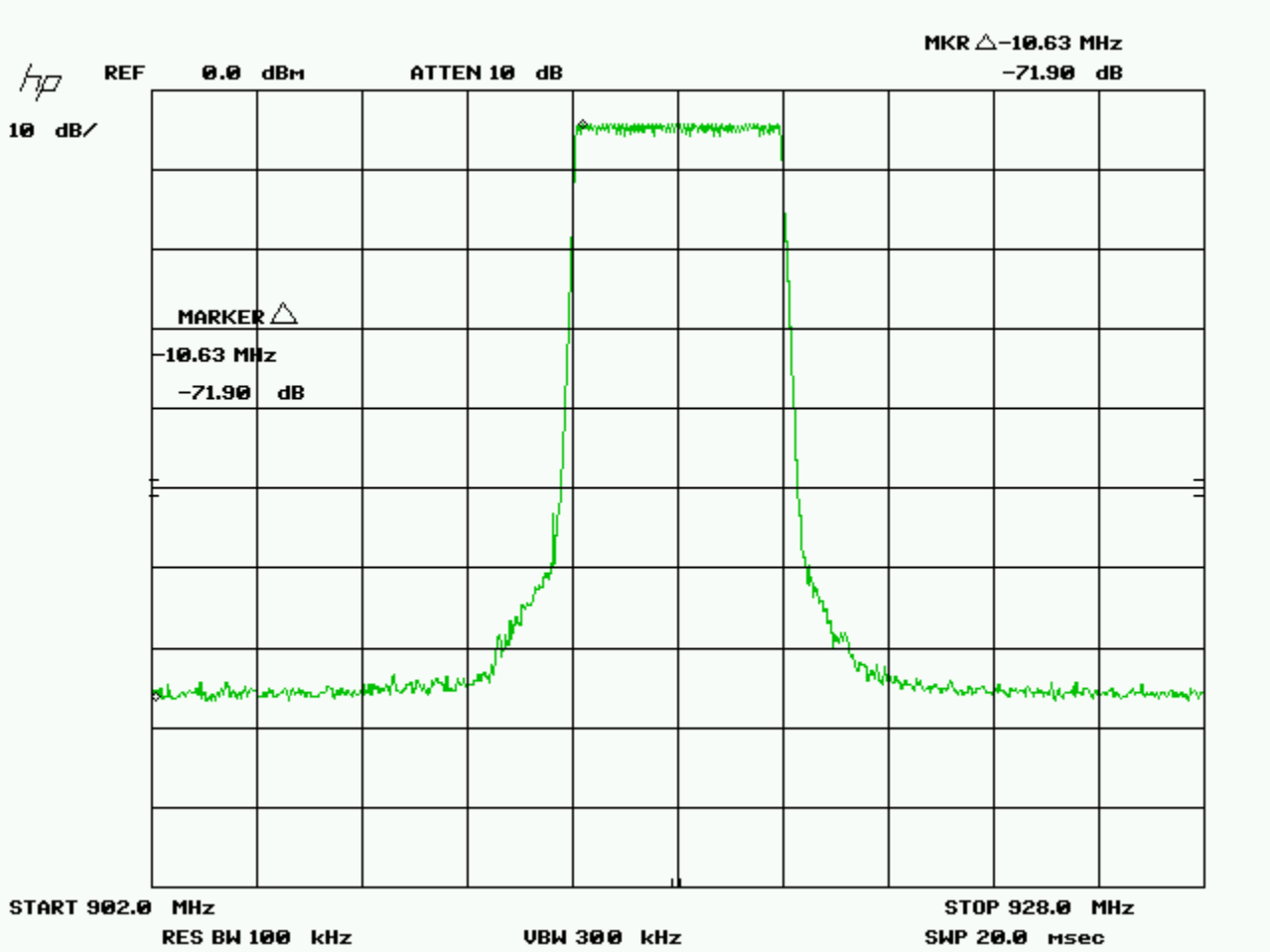
Graph(s)

The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT. Note there was 20 dB of external attenuation taken during this measurement.

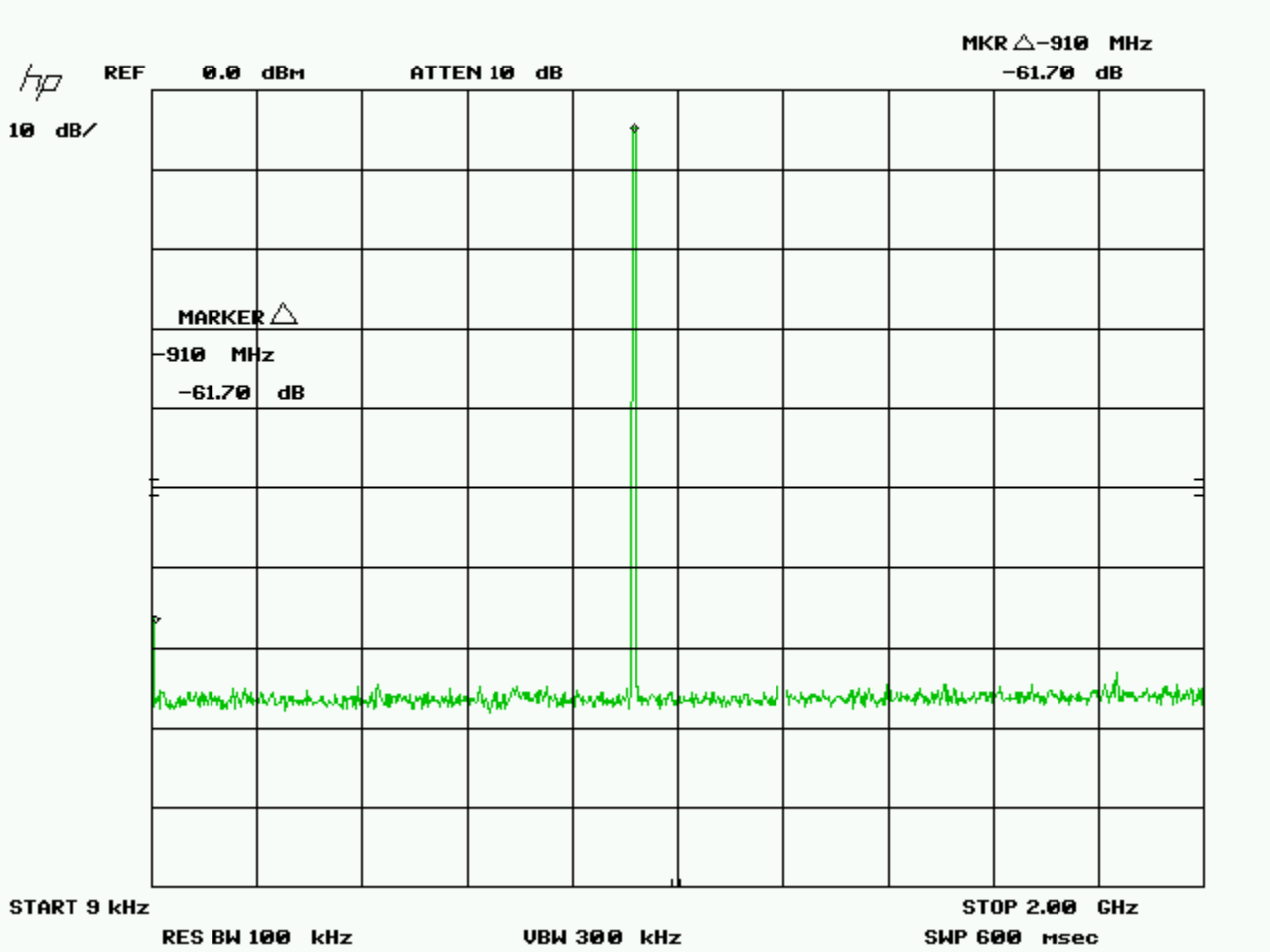
Hop mode Hi End



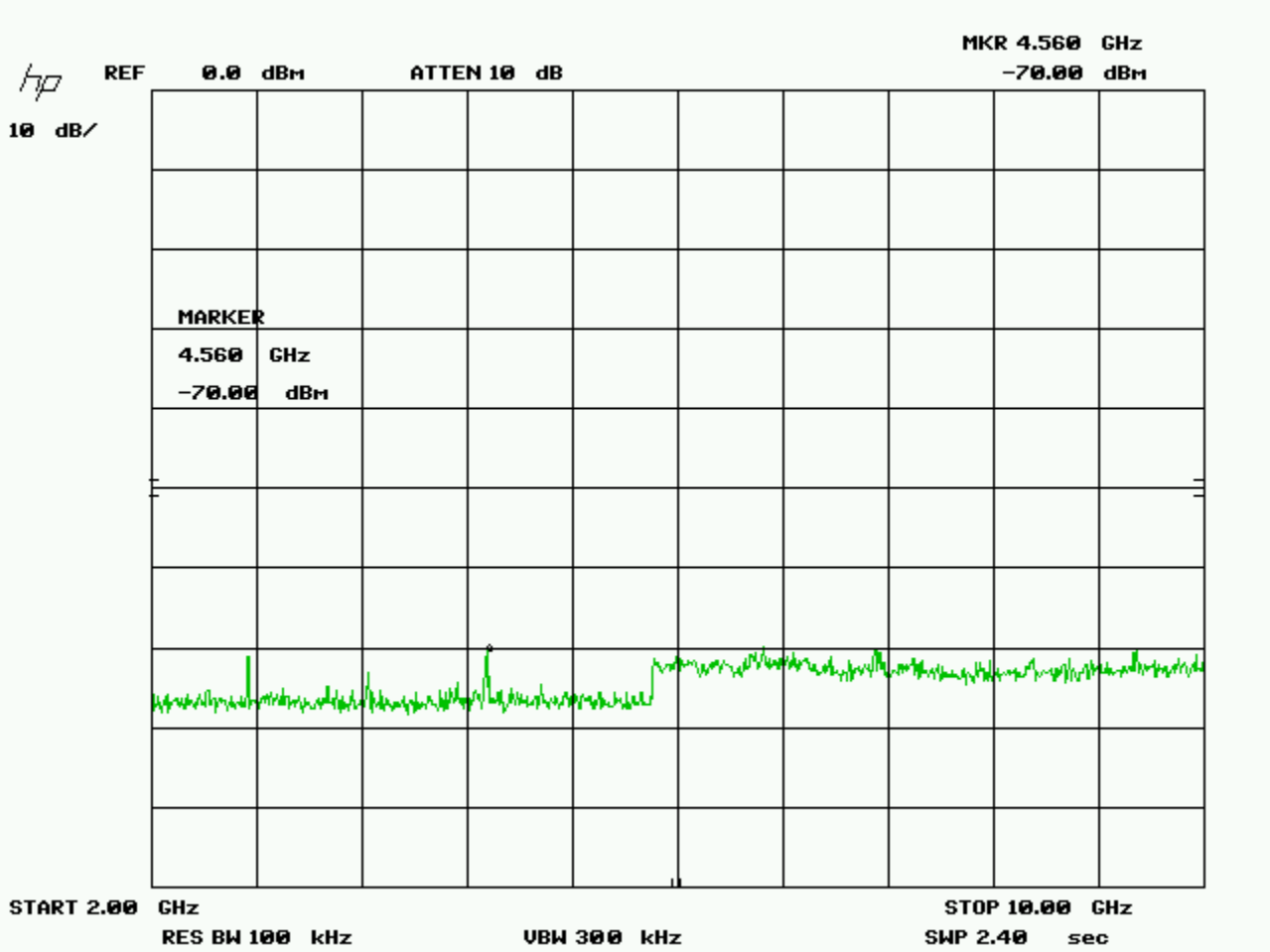
Hop mode Lo End



9 kHz – 2 GHz (Hop mode)



2 GHz – 10 GHz (Hope mode)



Note: The peak power shown here is raw data and no factors are applied to the reading.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2008-02-28	2010-02-28	GEMC 6
Quasi Peak Adapter	85650A	HP	2008-02-28	2010-02-28	GEMC 7
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	GEMC 40
Pre-Amplifier	PA-2.5-26	Vican	8/26/2008	8/26/2010	GEMC 9
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31
Attenuator 6 dB	FP-50-6	Trilithic	NCR	NCR	GEMC 41
Attenuator 10 dB	FP-50-10	Trilithic	NCR	NCR	GEMC 42
Attenuator 20 dB	FP-50-20	Trilithic	NCR	NCR	GEMC 43

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Frequency Allocation Use for Frequency Hopping Systems

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is within the allocated band. If the lowest frequency used is lower then the lower 'band edge' frequency, then band edge measurements must be performed as part of the unintentional radiated limits. If the highest frequency used is higher then the upper 'band edge' frequency, then band edge measurements must be performed as part of the unintentional radiated limits. The upper and lower frequency limit is calculated by using detector BW used to measure the unintentional emissions at the lower and upper frequencies.

This also helps prevent unintentional interference with other devices.

Limits

The limits are as defined in 47 CFR FCC Part 15 Section 15.247

	902 to 928 MHz	2.4 to 2.4835 GHz	5.275 to 5.85 GHz
15.209 Detector BW	120 kHz	1 MHz	1 MHz
Band edge	902.12 to 927.88 MHz	2.401 MHz to 2.4825 GHz	5.276 to 5.849 GHz

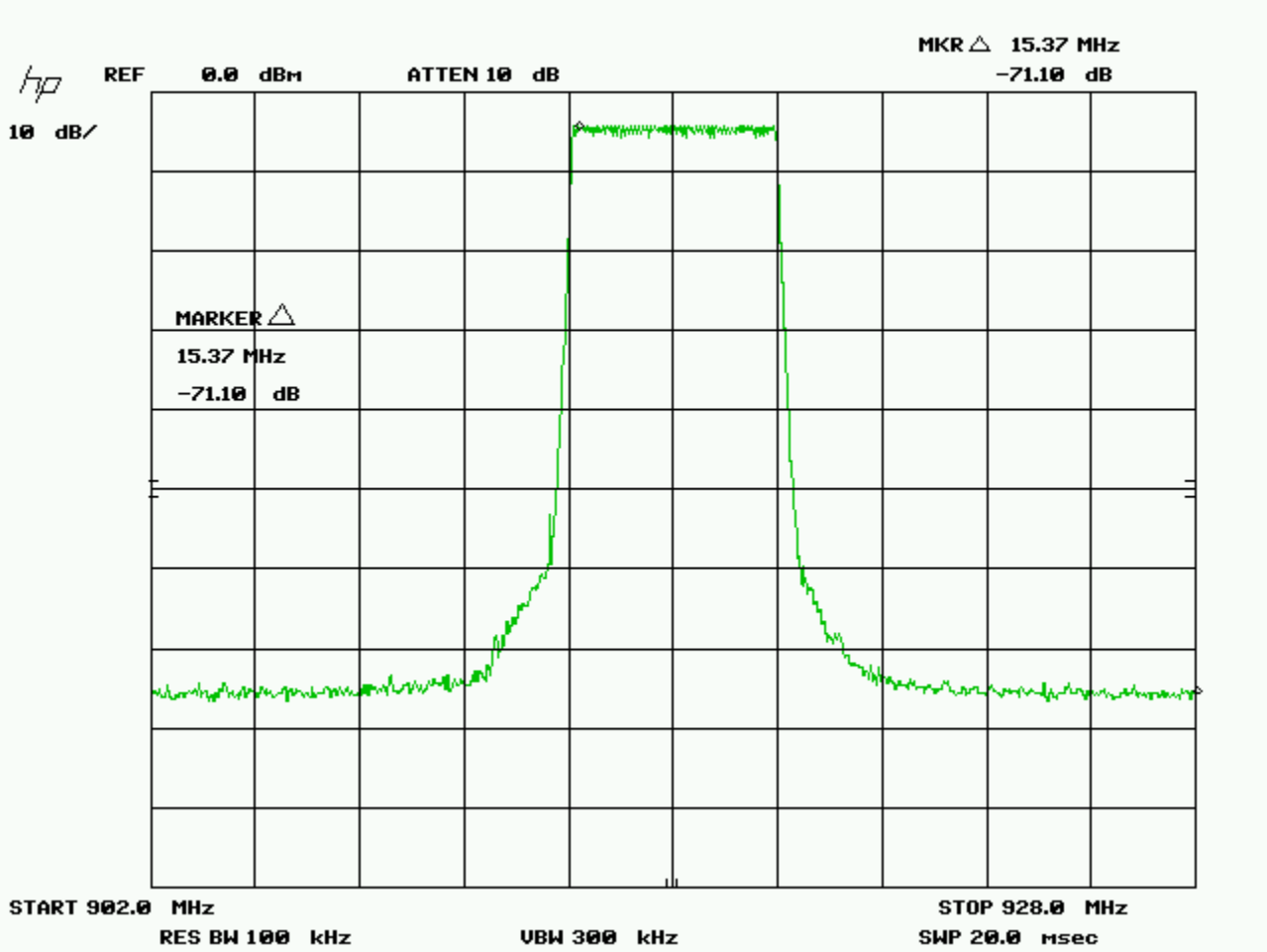
Results

The EUT passed the requirements without requiring radiated emissions band edge measurements.

Graph(s)

The graphs shown below show the start frequency and the stop frequency of the occupied channels during normal operation of the EUT.

Start and stop frequency



Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2008-02-28	2010-02-28	GEMC 6
Quasi Peak Adapter	85650A	HP	2008-02-28	2010-02-28	GEMC 7
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	GEMC 40
Pre-Amplifier	PA-2.5-26	Vican	8/26/2008	8/26/2010	GEMC 9
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Power Line Conducted Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT's power line does not exceed the limits listed below as defined in the applicable test standard, as measured from a LISN. This helps protect lower frequency radio services such as AM radio, shortwave radio, amateur radio operators, maritime radio, CB radio, and so on, from unwanted interference.

Limits & Method

The limits are as defined in 47 CFR FCC Part 15 Section 15.207
Method is as defined in ANSI C64:2003

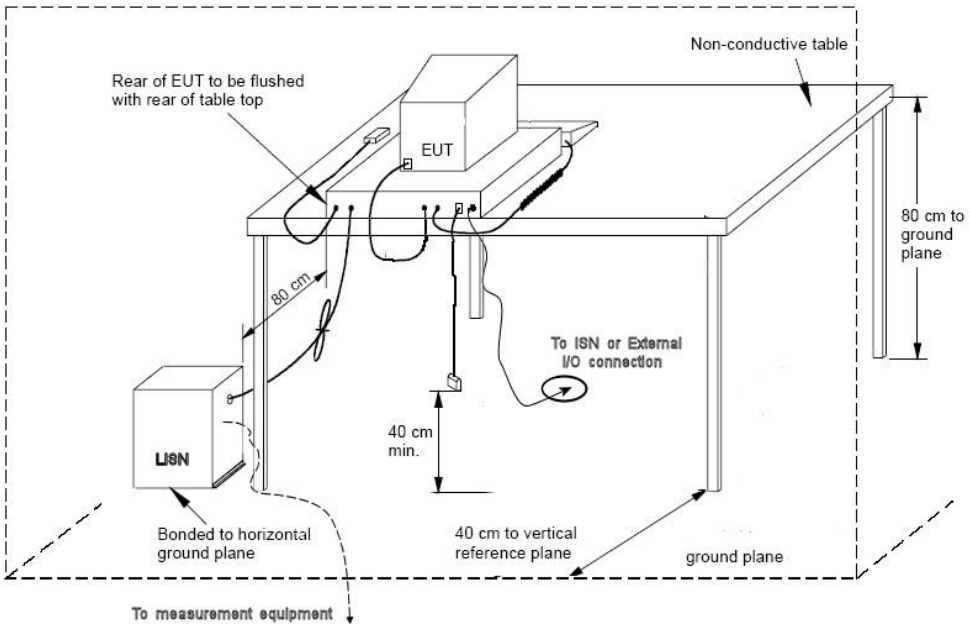
Average Limits		QuasiPeak Limits	
150 kHz – 500 kHz	56 to 46 dBuV	150 kHz – 500 kHz	66 to 56 dBuV
500 kHz – 5 MHz	46 dBuV	500 kHz – 5 MHz	56 dBuV
5 MHz – 30 MHz	50 dBuV	500 kHz – 30 MHz	60 dBuV

The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

Note: If the Peak or Quasi Peak detector measurements do not exceed the Average limits, then the EUT is deemed to have passed the requirements.

Both limits are applicable, and each is specified as being measured with a 9 kHz measurement bandwidth.

Typical Setup Diagram



Note: The vertical reference plane is optional as per ANSI C63.4 section 5.2.2

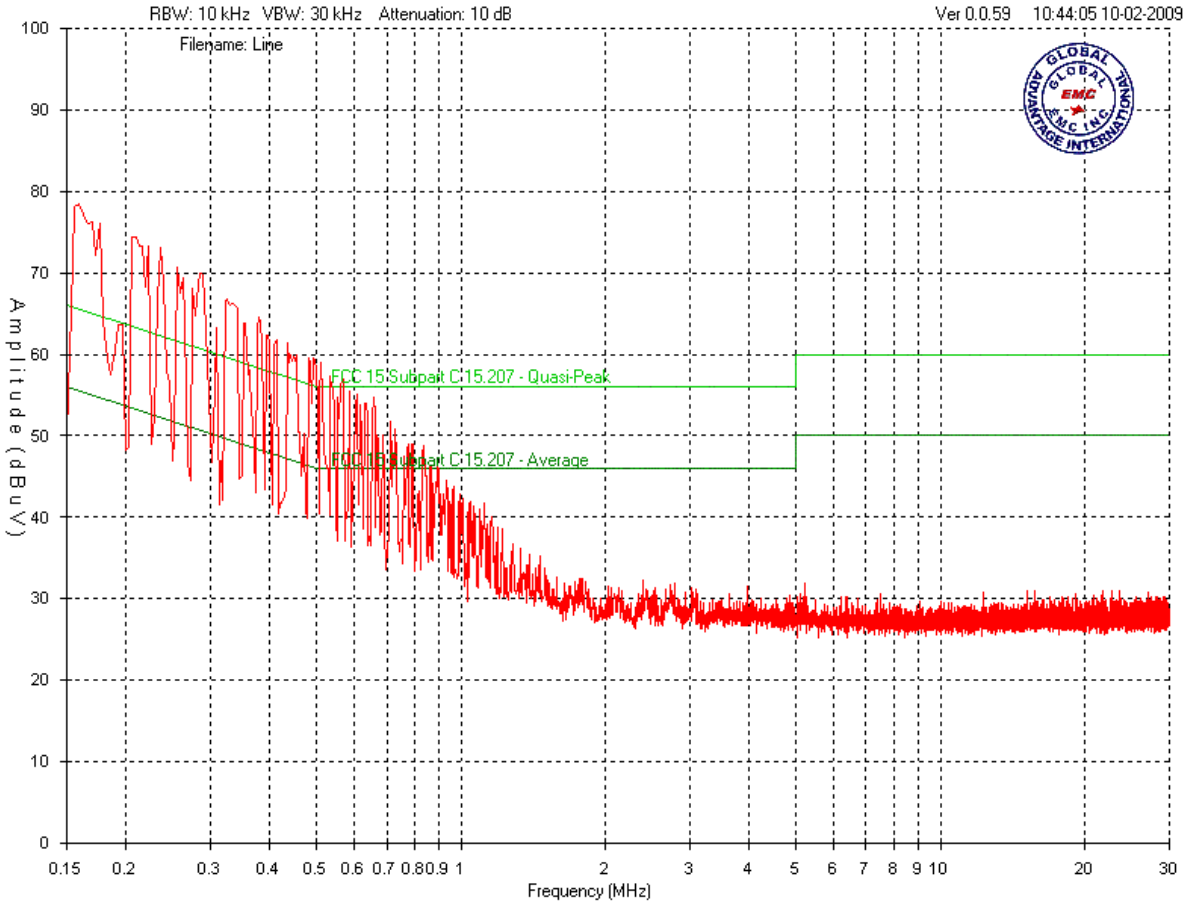
Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-3.6 dB with a 'k=2' coverage factor and a %95 confidence level.

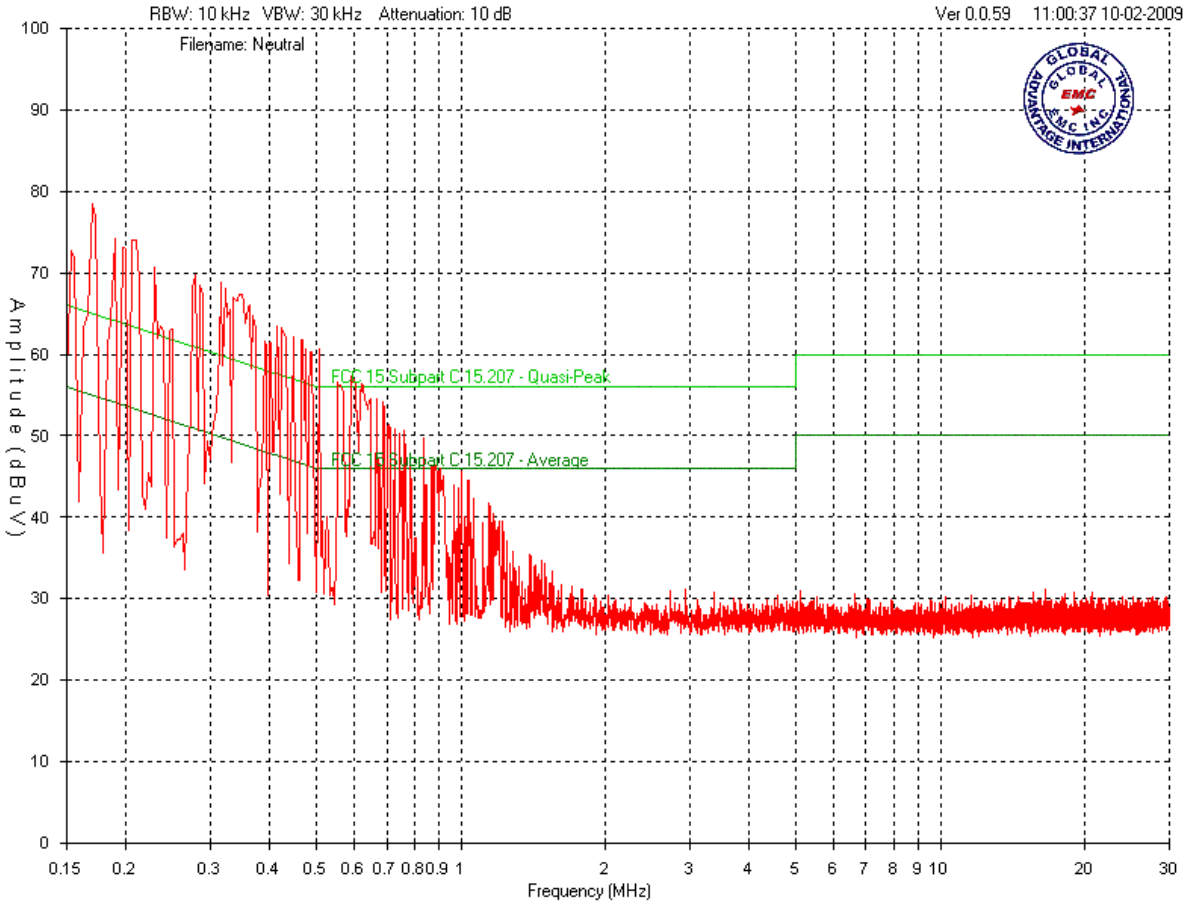
Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector where applicable, please refer to the table. The graph shown below is a peak measurement graph, measured with a resolution bandwidth greater then or equal to the final required detector. These graphs are performed as a worst case measurement to enable the detection of frequencies of concern and for considerable time savings.

120V 60Hz Line

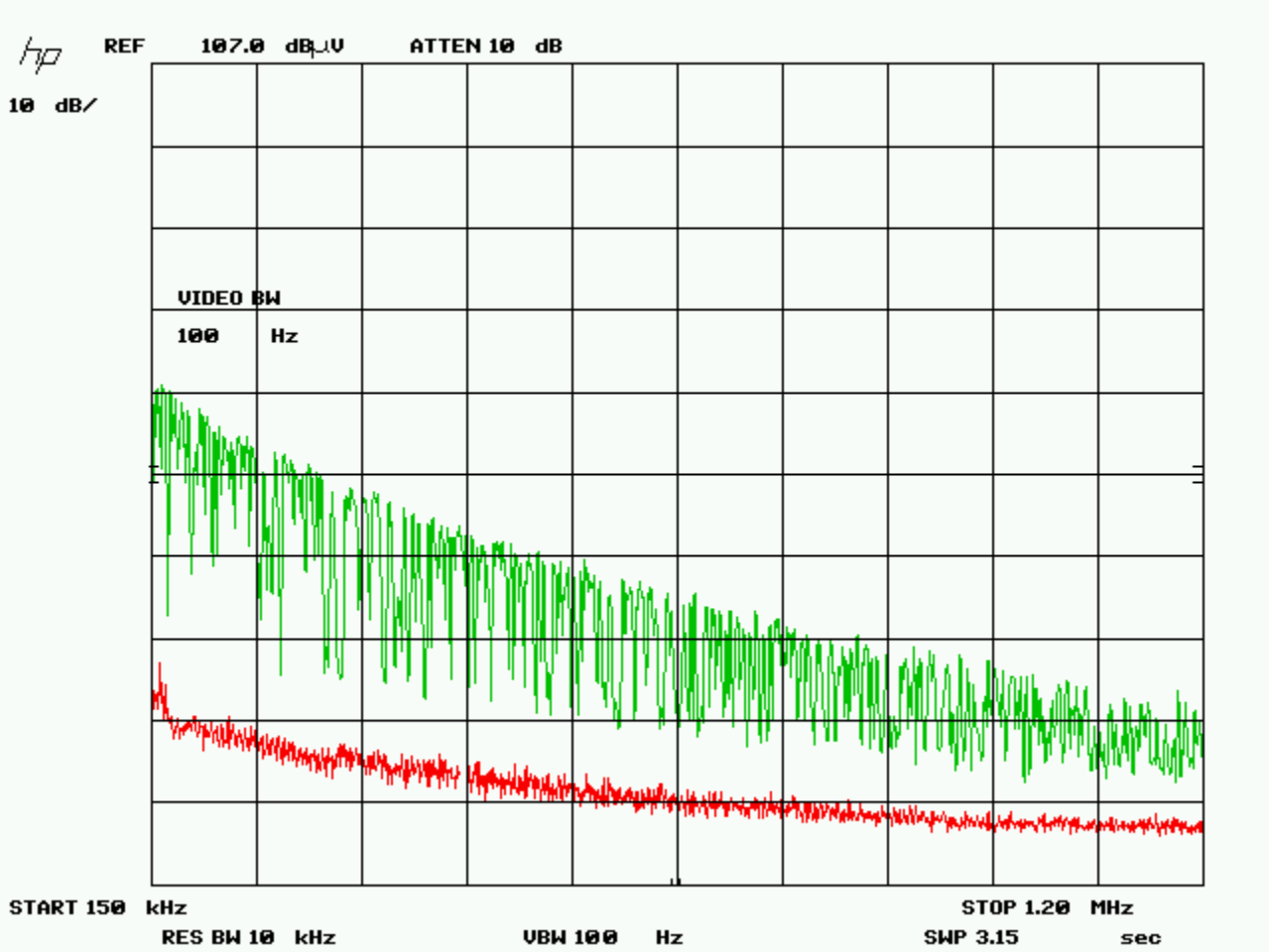


120V 60Hz Neutral



Pk Vs Avg

This plot illustrates that all the noise below 1 MHz is highly transient in nature.



Client	Lyngsoe Systems
Product	TT8350LSA
Standard(s)	RSS 210 Issue 7:2007 / FCC Part 15 Subpart C 15:2006

Final Measurements

Average Emissions Table

Product category	Class B Avg								
Project	Lyngsoe								
Test Frequency (MHz)	**Detection mode (Q-Peak / Avg)**	**Raw signal (dBuV)**	**Cable loss (dB)**	**Attenuator (dB)**	**LISN factor (dB)**	**Received signal (dBuV)**	**Emission limit (dBuV)**	**Margin (dBuV)**	**Result**
120V 60Hz L									
0.15	Avg	35	0.2	10	0.05	45.25	56	10.75	PASS
0.3	Avg	32.1	0.2	10	0.03	42.33	52	9.67	PASS
0.57	Avg	28.8	0.2	10	0.02	39.02	46	6.98	PASS
120V 60Hz N									
0.15	Avg	32.2	0.2	10	0.05	42.45	56	13.55	PASS
0.3	Avg	31.1	0.2	10	0.03	41.33	52	10.67	PASS
0.57	Avg	27.6	0.2	10	0.02	37.82	46	8.18	PASS

QP Emissions Table

Product category	Class B QP								
Project	Lyngsoe								
Test Frequency (MHz)	**Detection mode (Q-Peak / Avg)**	**Raw signal (dBuV)**	**Cable loss (dB)**	**Attenuator (dB)**	**LISN factor (dB)**	**Received signal (dBuV)**	**Emission limit (dBuV)**	**Margin (dBuV)**	**Result**
120V 60Hz L									
0.15	QP	48	0.2	10	0.05	58.25	66	7.75	PASS
0.3	QP	38	0.2	10	0.03	48.23	62	13.77	PASS
0.57	QP	30	0.2	10	0.02	40.22	56	15.78	PASS

120V 60Hz N									
0.15	QP	47.2	0.2	10	0.05	57.45	66	8.55	PASS
0.3	QP	39.2	0.2	10	0.03	49.43	62	12.57	PASS
0.57	QP	29.3	0.2	10	0.02	39.52	56	16.48	PASS

Note:

1. See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up for the highest line conducted emission

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2008-02-28	2010-02-28	GEMC 6
Quasi Peak Adapter	85650A	HP	2008-02-28	2010-02-28	GEMC 7
LISN	FCC-LISN-50/250-16-2-01	FCC	2007-05-02	2009-05-02	GEMC 65
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
Attenuator 10 dB	FP-50-10	Trilithic	NCR	NCR	GEMC 42

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Maximum Permissible Exposure

Purpose

The purpose of this test is to ensure that the RF energy intentionally transmitted, in terms of power density emitted from the EUT at a stated operating distance does not exceed the limits listed below as defined in the applicable test standard, as calculated based upon readings obtained during testing. This helps protect human exposure to excessive RF fields.

Limit(s) and Method

The limits, as defined in FCC 15.247(i) and FCC 1.1310 Table 1 (A) limits for occupational/controlled exposure was applied. The limit for the frequency range of <300 MHz to 1500 MHz is f/300 mW/cm^2,> where f is the frequency in MHz. For a worst case limit, the lowest frequency used was for limit calculation purposed. The limit was calculated to be 900/300, or 3.0 mW/cm^2. The distance used for calculations was 2.5cm, as this is the minimum distance an operator will be from the EUT during normal operation.

Measurement Uncertainty

Measurement uncertainty does not apply to this requirement, as this is a calculated result based upon readings obtained. The measurement uncertainty of this calculation can be approximated by the measurement uncertainty of the peak power, combined with the measurement uncertainty of the antenna gain, which was not available at the time of evaluation.

Results

The EUT passed the requirements. The worst case calculated power density was 1.24 mW/cm^2 this is under the 3.0 mW/cm^2 requirement.

Calculations

Method 1 (conducted power)

$P_d = (P_t * G) / (4 * pi * R^2)$
Where Pt = 15.8 dBm or 38.0 mW as per Peak power conducted output
Where G = 4.1 dB, or numerically 2.57
Where R = 2.5 cm

$P_d = (38.0\ mW * 2.57) / (4 * pi * 2.5cm^2)$
$P_d = 97.72\ mW / 78.53\ cm^2$

$P_d = 1.24\ mW/cm^2$

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2008-02-28	2010-02-28	GEMC 6
Quasi Peak Adapter	85650A	HP	2008-02-28	2010-02-28	GEMC 7
Attenuator 3 dB	FP-50-3	Trilithic	NCR	NCR	GEMC 40
Pre-Amplifier	PA-2.5-26	Vican	8/26/2008	8/26/2010	GEMC 9
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31

This report module is based on GEMC template "FCC - 15.209 - Radiated Emissions_Rev1.doc"

Appendix A – EUT Summary

For further details for filing purposes, refer to filing package.

General EUT Description

Manufacturer	Lyngsoe Systems 5570 Kennedy Road, Unit B, Mississauga, ON, Canada L4Z 2A9 www.lyngsoesystems.com
EUT Name	TT8350LSA
Equipment Category (Commercial / Residential / Medical)	Industrial use RF transmitter.
Input Voltage and Frequency	Operated from DC power supply
Intentional RF (If yes describe)	Yes – 912.5 to 917.5 MHz FHSS
Table Top / Wall mount / Floor standing (choose table top if unsure)	Handheld.
Peripherals required for test	No peripherals are needed to exercise the EUT.
Minimum Separation distance from operator	2.5 cm

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated. For a close-up picture of the EUT, see 'Appendix B – EUT & Test Setup Photographs'.

EUT Functional Description

EUT Configuration

The EUT is a battery operated device that can is used for tracking delivery / postal applications. It is charged using an AC-DC power supply brick. The EUT was tested on all 3 axes and the worst case (vertical) is recorded here. The EUT required a ferrite bead on the antenna cable in order to comply spurious radiated emissions.

Operational Setup

For medium, low and high channel measurements software was available such that the transmitter could to be tuned to those frequencies.

For spurious emissions, number of channels occupied, frequency allocation radiated tests were performed. For all other tests an SMA connector was provided by the manufacturer on the output of the antenna port and all other tests were carried out using conducted measurements.

Test Signals Required For Test

The following patterns or signals were generated during test by the peripherals as described above to exercise the EUT during testing.

None required.

Modifications Required for Compliance

A steward ferrite bead (28A0434-0A2) with no turns was used on the antenna cable in order to comply with radiated emission requirements.

Appendix B – EUT and Test Setup Photographs

Note: These photos are for information purposes only. Also refer to PDF files that are separate from this test report.

Figure 1: Radiated emissions

Figure 2: Ferrite bead used for radiated emissions

Figure 3: Conducted emissions

Figure 4: Power supply