

FCC/ISED DTS Test Report

Prepared for: Garmin International Inc.

Address: 1200 E. 151st Street
Olathe, Kansas, 66062, USA

Product: A03587
B03587

Test Report No: R20190211-22-03A

Approved By:



Nic S. Johnson, NCE

Technical Manager

iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: 24 April 2019

Total Pages: 118

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	Report Number:	R20190211-22-03A	Rev	A
	Prepared for:	Garmin		

REVISION PAGE

Rev. No.	Date	Description
0	28 March 2019	Original – NJohnson Prepared by KVepuri/CFarrington
A	24 April 2019	Page 4 was updated to state that duty cycle was not applicable. -NJ Includes NCEE Labs report R20190211-22-03 and its amendment in full.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

CONTENTS

Revision Page.....	2
1.0 Summary of test results.....	4
2.0 EUT Description	5
2.1 Equipment under test.....	5
2.2 Description of test modes.....	6
2.3 Description of support units	6
3.0 Laboratory description	7
3.1 Laboratory description	7
3.2 Test Personnel	7
3.3 Test equipment	8
4.0 Detailed results	9
4.1 Duty Cycle	9
4.2 Radiated emissions	10
4.3 Peak Output Power	36
4.4 Bandwidth	56
4.5 Bandedges	76
4.6 Power Spectral Density	104
Appendix A: Sample Calculation	115
Appendix B – Measurement Uncertainty.....	117
REPORT END.....	118

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

1.0 SUMMARY OF TEST RESULTS

The worst-case measurements were reported in this report. The EUT has been tested according to the following specifications:

APPLIED STANDARDS AND REGULATIONS		
Standard Section	Test Type	Result
FCC Part 15.35 RSS Gen, Issue 4, Section 6.10	Duty Cycle	N/A
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Peak output power	Pass
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass
FCC Part 15.209 RSS-Gen Issue 4, Section 7.1	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 4, Section 8.9	Transmitter Radiated Emissions	Pass
FCC Part 15.247(a)(1) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 11.13	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 4, Section 7.1	Conducted Emissions	Pass

See Section 4 for details on the test methods used for each test.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

The Equipment Under Test (EUT) was a portable transceiver from Garmin. It features 802.11b, 802.11g, 802.11n, GFSK and GMSK radios with transmit and receive capabilities.

Model	A03587, 10" model B03587, 12" model
EUT Received	8 March 2019
EUT Tested	8 March 2019 - 26 March 2019
Serial No.	146094034018 (12" unit; used for conducted measurements) 146094034059 (12" unit; used for radiated measurements) 146094024091 (10" unit; used for radiated measurements)
Operating Band	2400.0 - 2483.5 GHz
Device Type	802.11b, 802.11g, 802.11n
Antenna	Trace Antenna
Power Supply	12VDC

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

NOTE 2: This report is intended to cover both 10-inch and 12-inch models. However, the report reflects the measurements made on 12 -inch model, as the radio portion of the both the units is identical. Spurious emissions measurements from 30MHz – 1 GHz were performed on both models.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency
Low (Channel 1)	2412, 2402 (BLE, ANT+)
Middle (Channel 6)	2437, 2440 (BLE, ANT+)
High (Channel 11)	2462, 2480 (BLE, ANT+)

As well as the following modes:

WIFI Mode
802.11b
802.11g
802.11n (HT20)

These are the only three representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, highest and one channel in the middle.

2.3 DESCRIPTION OF SUPPORT UNITS

NA

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

3.0 LABORATORY DESCRIPTION

3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
 4740 Discovery Drive
 Lincoln, NE 68521

A2LA Certificate Number:	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A-1
NCC CAB Identification No:	US0177

Environmental conditions varied slightly throughout the tests:

Relative humidity of $35 \pm 4\%$
 Temperature of $22 \pm 3^{\circ}$ Celsius

3.2 TEST PERSONNEL

All testing was performed by Karthik Vepuri of NCEE Labs. The results were reviewed by Nic Johnson.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Rohde & Schwarz Test Receiver	ES126	100037	30 Jan 2018	30 Jan 2020
EMCO Biconilog Antenna	3142B	1647	02 Aug 2017	02 Aug 2019
EMCO Horn Antenna	3115	6416	26 Jan 2018	26 Jan 2020
EMCO Horn Antenna	3116	2576	31 Jan 2018	31 Jan 2020
Rohde & Schwarz Preamplifier	TS-PR18	3545700803	09 Mar 2018*	09 Mar 2020*
Trilithic High Pass Filter	6HC330	23042	09 Mar 2018*	09 Mar 2020*
RF Cable (preamplifier to antenna)	MFR-57500	01-07-002	09 Mar 2018*	09 Mar 2020*
RF Cable (antenna to 10m chamber bulkhead)	FSCM 64639	01E3872	09 Mar 2018*	09 Mar 2020*
RF Cable (10m chamber bulkhead to control room bulkhead)	FSCM 64639	01E3874	09 Mar 2018*	09 Mar 2020*
RF Cable (Control room bulkhead to RF switch)	FSCM 64639	01E3871	09 Mar 2018*	09 Mar 2020*
RF Cable (RF switch to test receiver)	FSCM 64639	01F1206	09 Mar 2018*	09 Mar 2020*
RF switch – Rohde and Schwarz	TS-RSP	1113.5503.14	09 Mar 2018*	09 Mar 2020*
N connector bulkhead (10m chamber)	PE9128	NCEEBH1	09 Mar 2018*	09 Mar 2020*
N connector bulkhead (control room)	PE9128	NCEEBH2	09 Mar 2018*	09 Mar 2020*

*Internal Characterization

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

4.0 DETAILED RESULTS

4.1 DUTY CYCLE

Duty Cycle: N/A

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

4.2 RADIATED EMISSIONS

Test Method: ANSI C63.10:2013:

1. Section 6.5, "Radiated emissions from unlicensed wireless devices in the frequency range of 30 MHz to 1000 MHz"
2. Section 6.6, "Radiated emissions from unlicensed wireless devices above 1 GHz"
3. Section 11.11, "Measurement in nonrestricted frequency bands"
4. Section 11.12, "Emissions in restricted bands"

Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (MHz)	FIELD STRENGTH (μV/m)	MEASUREMENT DISTANCE (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note about requirement from FCC Part 15.247(d) and RSS-247, Section 5.5:

In addition to the limits shown above, all emissions were also required to be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. All measurements were performed with a 1 MHz bandwidth, but the bandwidth conversion from 1 MHz to 100 kHz would be equally applied to the highest emission and the spurious emissions, so it would not effect the delta measurement.

Since the fundamental emissions was at least 20 dB over the spurious emissions limits from 15.209 and all spurious emissions were below the 15.209 limit, this requirement was met.

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBμV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

Test procedures:

- a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements from 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.
- d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.
- e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.
- f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- g. All 802.11 modes were examined (b, g, n, HT20) and it was found the 802.11n mode produced the highest emissions. All final measurements were performed with the EUT transmitting continuously in this mode.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.
2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

Deviations from test standard:

No deviation.

Test setup:

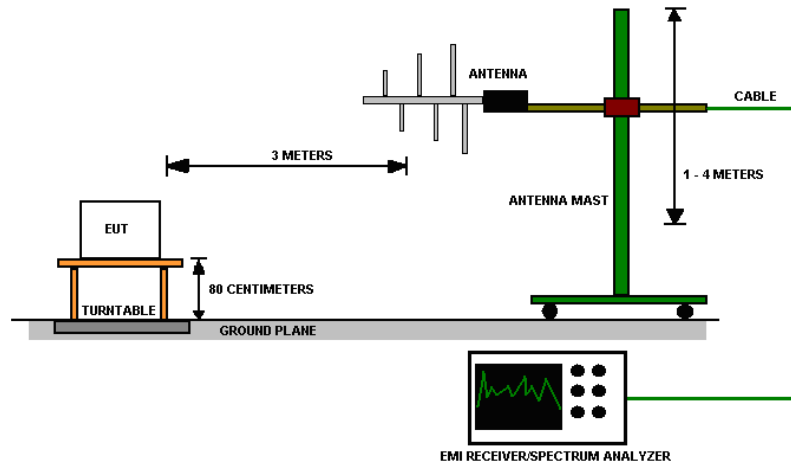


Figure 1 - Radiated Emissions Test Setup

EUT operating conditions

The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range. EUT was set to transmit in 80211b, 80211g and 80211n.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

Test results:

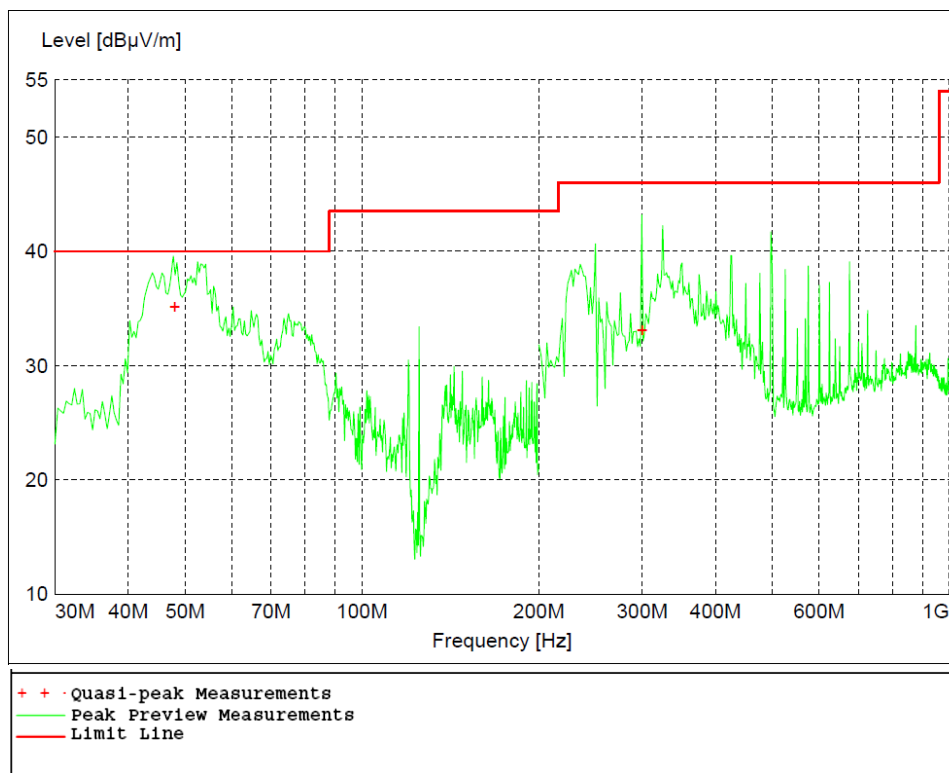


Figure 2 - Radiated Emissions Plot, Receive

Table 1 - Radiated Emissions Quasi-peak and Peak Measurements, Receive, 802.11b, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
48.000000	35.15	40.00	4.80	99	214	VERT
300.000000	33.12	46.00	12.90	99	238	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

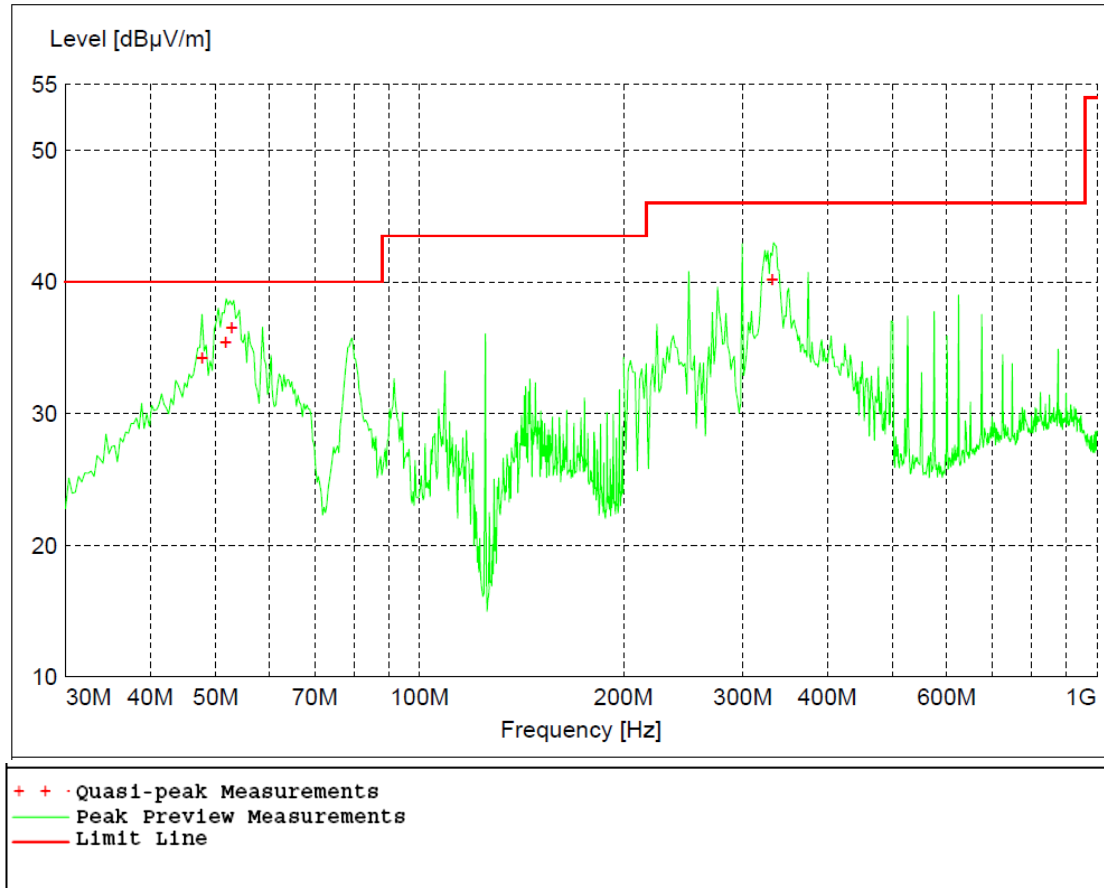


Figure 3 - Radiated Emissions Plot, Low Channel

Table 2 - Radiated Emissions Quasi-peak Measurements, Low Channel, 802.11b, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
47.760000	34.27	40.00	5.70	102	230	VERT
51.780000	35.44	40.00	4.60	98	76	VERT
52.800000	36.56	40.00	3.40	124	274	VERT
332.160000	40.20	46.00	5.80	100	0	HORI
47.760000	34.27	40.00	5.70	102	230	VERT

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

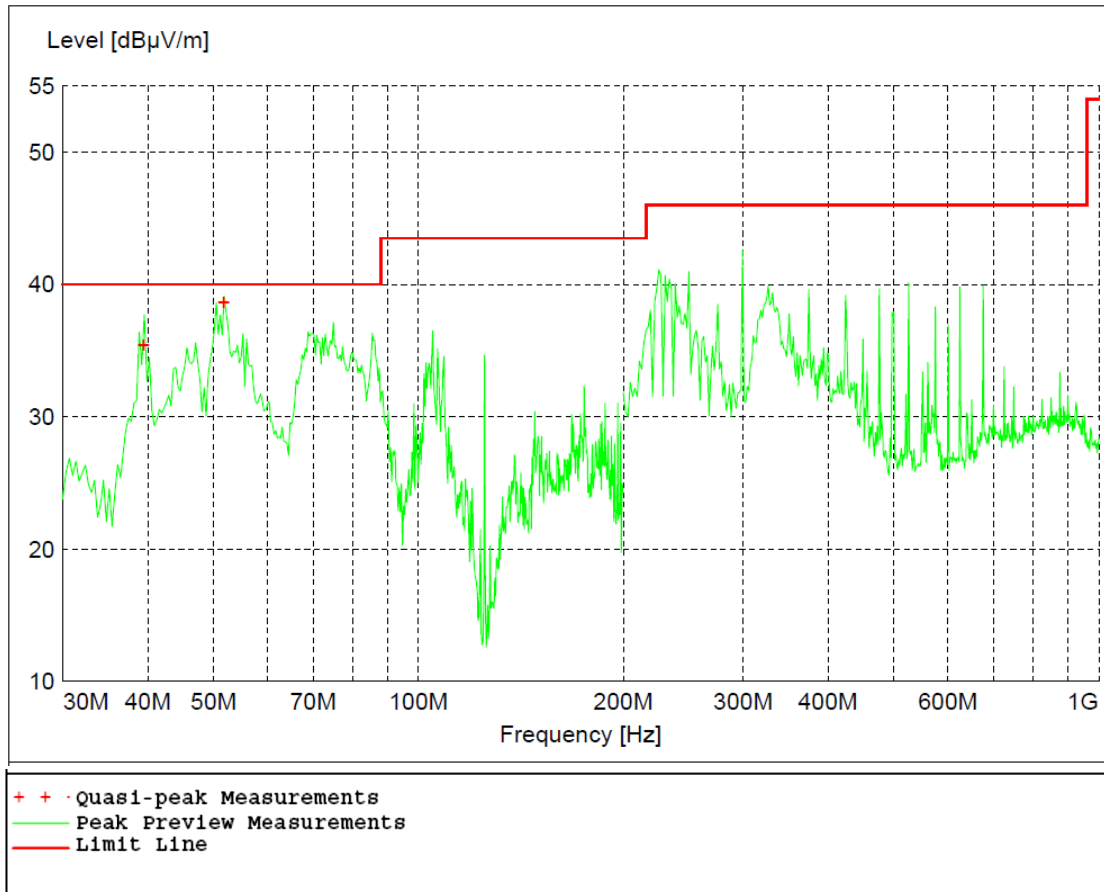


Figure 4 - Radiated Emissions Plot, Mid Channel

Table 3 - Radiated Emissions Quasi-peak Measurements, Mid Channel, 802.11b, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
39.480000	35.43	40.00	4.60	100	105	VERT
51.780000	38.68	40.00	1.30	100	101	VERT

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

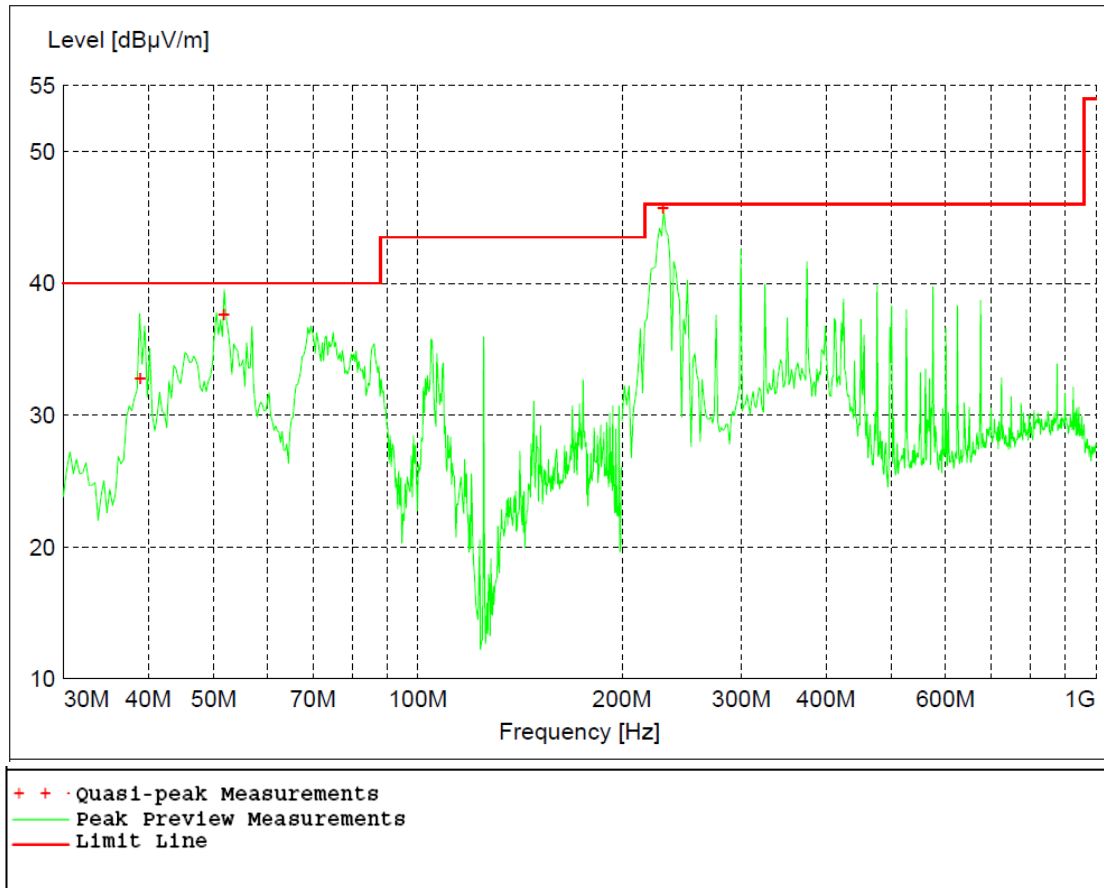


Figure 5 - Radiated Emissions Plot, High Channel

Table 4 - Radiated Emissions Quasi-peak Measurements, High Channel, 802.11b, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
38.940000	32.76	40.00	7.20	100	139	VERT
51.780000	37.62	40.00	2.40	112	114	VERT
229.980000	45.71	46.00	0.30	162	15	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

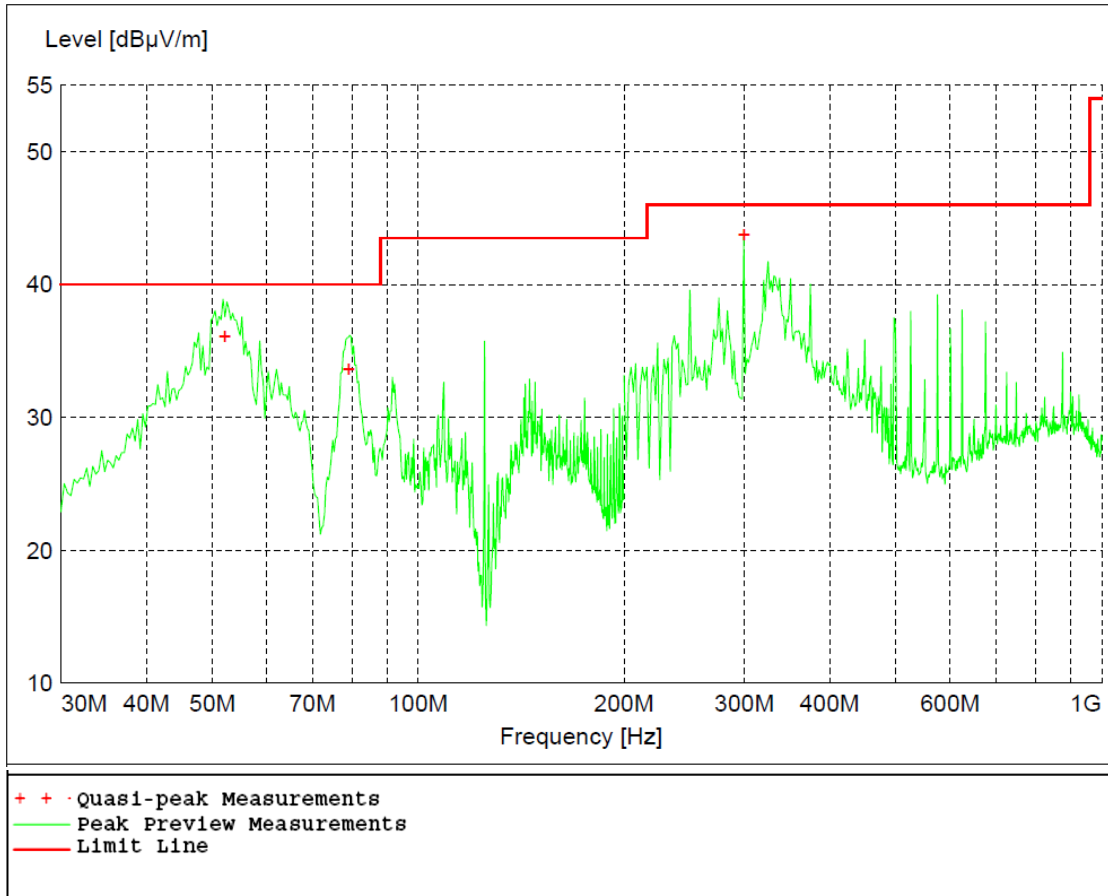


Figure 6 - Radiated Emissions Plot, Low Channel

Table 5 - Radiated Emissions Quasi-peak Measurements, Low Channel, 802.11g, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
52.140000	36.08	40.00	3.90	100	316	VERT
79.140000	33.65	40.00	6.30	136	360	VERT
300.000000	43.77	46.00	2.20	149	76	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

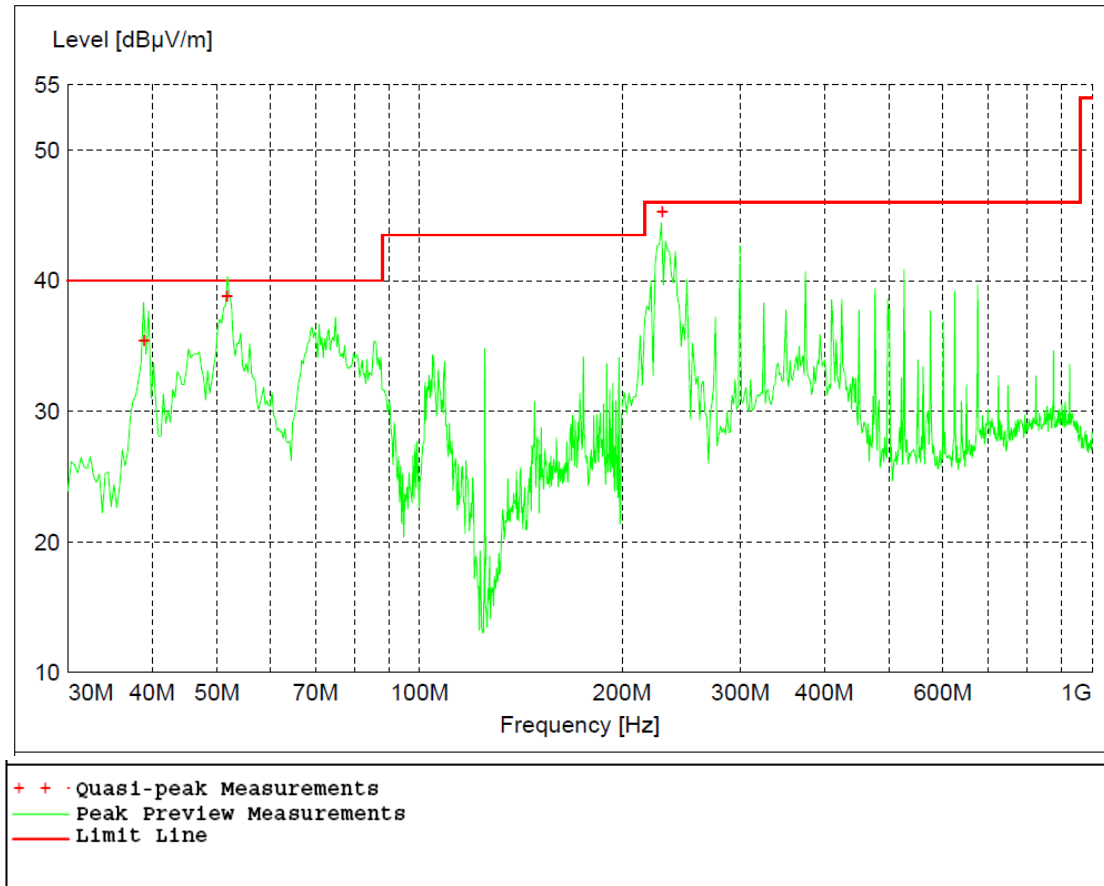


Figure 7 - Radiated Emissions Plot, Mid Channel

Table 6 - Radiated Emissions Quasi-peak Measurements, Mid Channel, 802.11g, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
38.940000	35.40	40.00	4.60	99	110	VERT
51.780000	38.88	40.00	1.10	100	121	VERT
229.860000	45.27	46.00	0.70	167	35	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

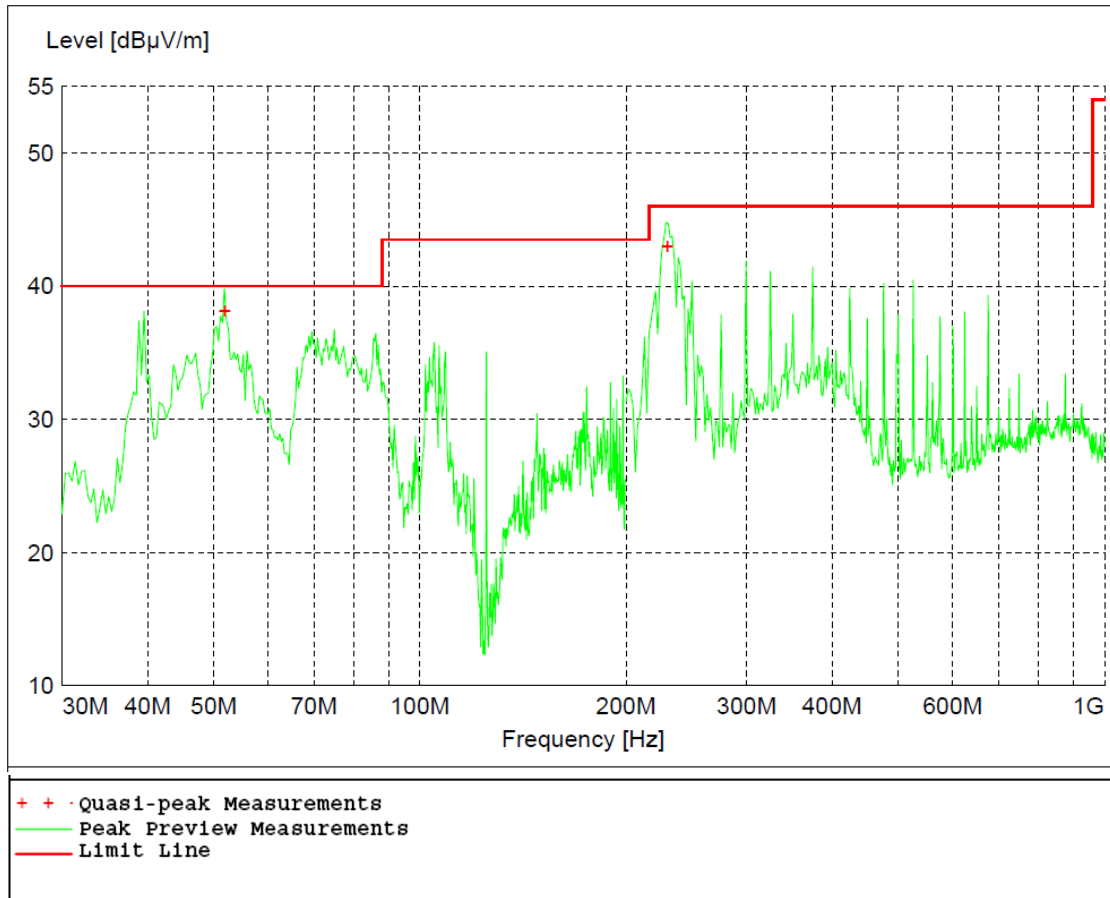


Figure 8 - Radiated Emissions Plot, High Channel

Table 7 - Radiated Emissions Quasi-peak Measurements, High Channel, 802.11g

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
51.900000	38.18	40.00	1.80	99	108	VERT
229.980000	42.97	46.00	3.00	169	20	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

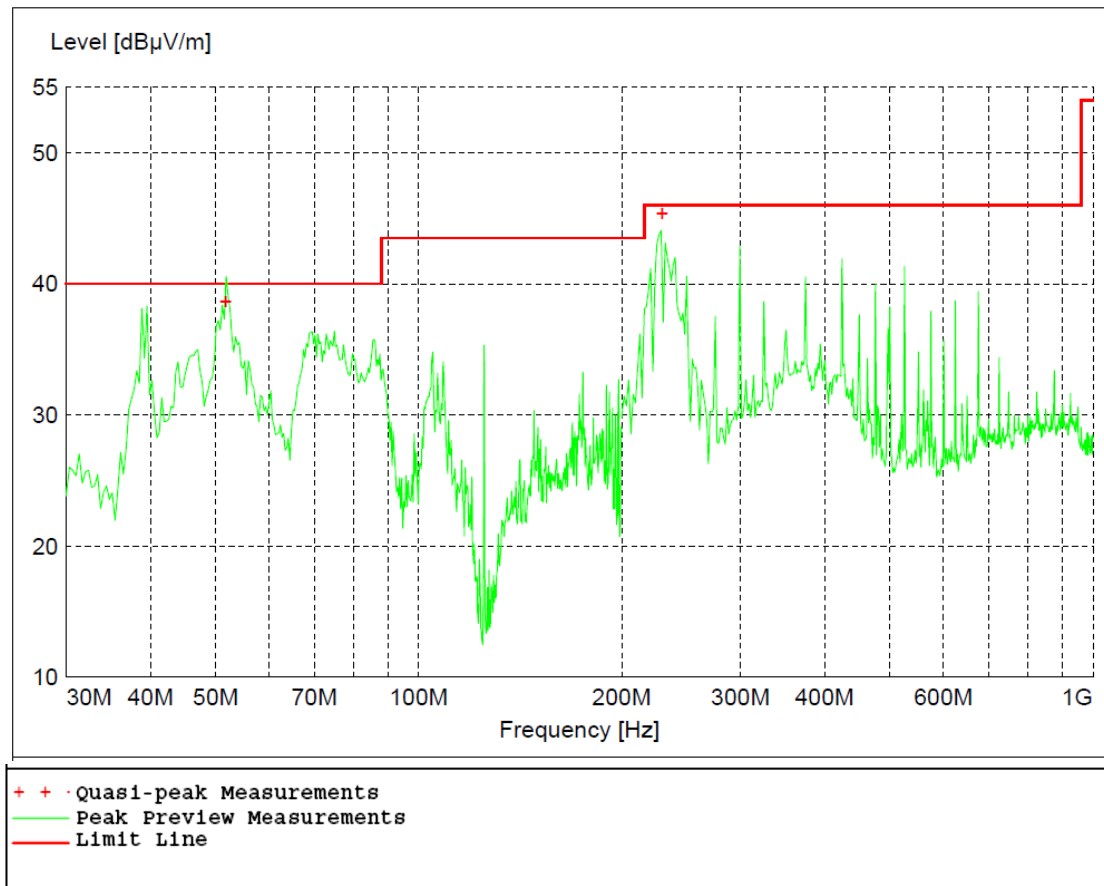


Figure 9 - Radiated Emissions Plot, Low Channel

Table 8 - Radiated Emissions Quasi-peak Measurements, Low Channel, 802.11n, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
51.780000	38.68	40.00	1.30	100	106	VERT
229.860000	45.37	46.00	0.60	156	30	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

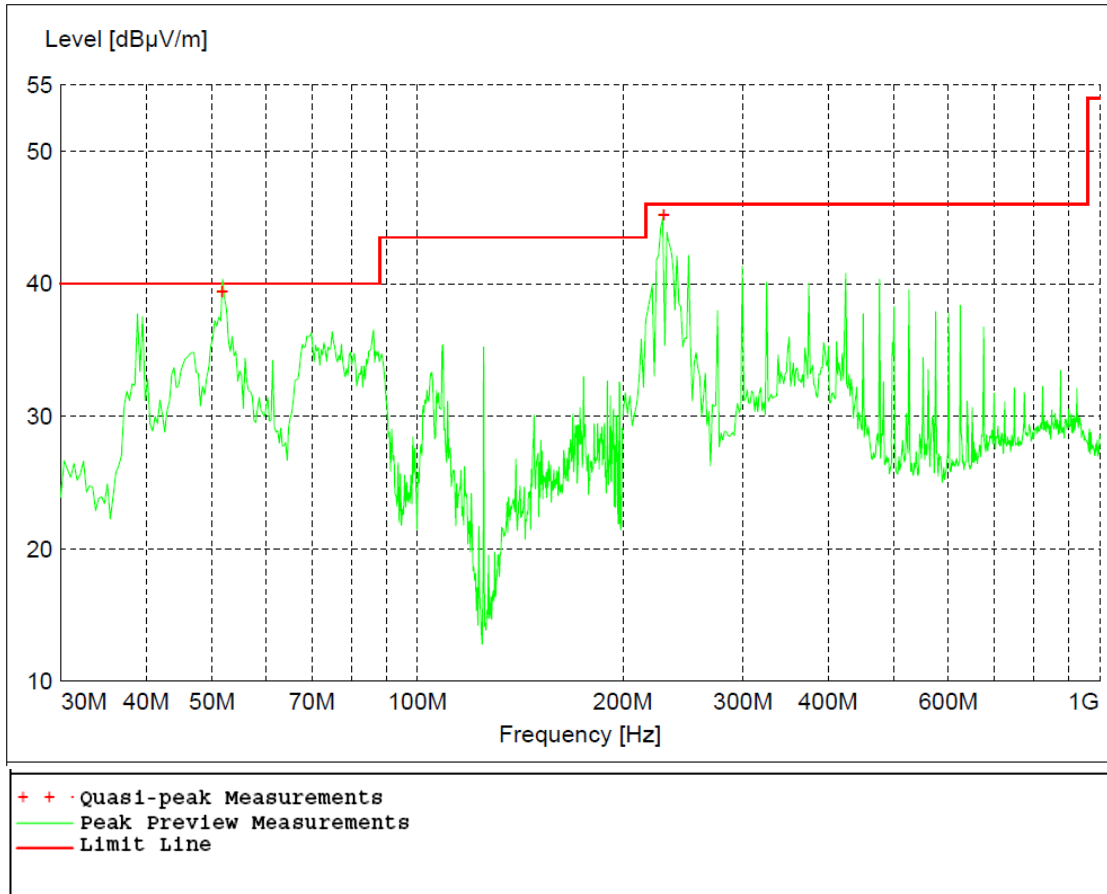


Figure 10 - Radiated Emissions Plot, Mid Channel

Table 9 - Radiated Emissions Quasi-peak Measurements, Mid Channel, 802.11n, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
51.780000	39.48	40.00	0.50	99	102	VERT
229.860000	45.22	46.00	0.80	137	20	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

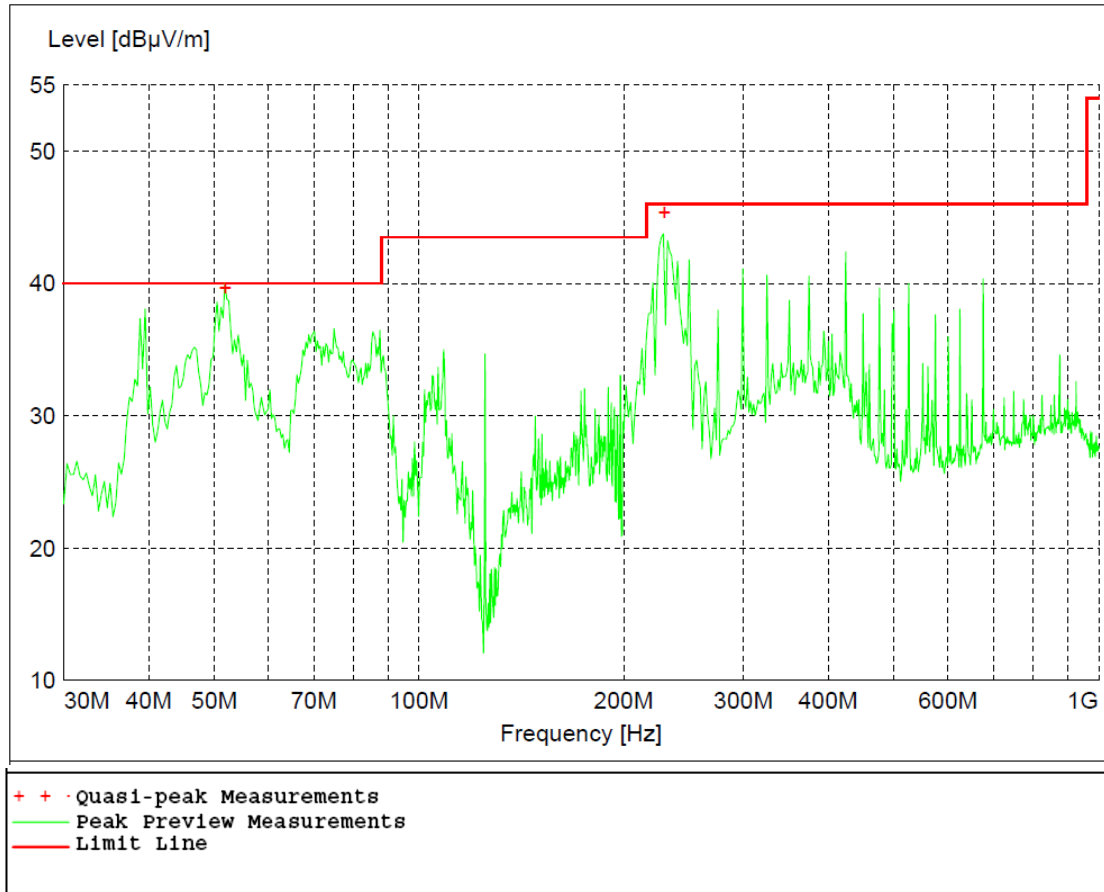


Figure 11 - Radiated Emissions Plot, High Channel

Table 10 - Radiated Emissions Quasi-peak Measurements, High Channel, 802.11n, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
51.900000	39.66	40.00	0.30	99	101	VERT
229.860000	45.36	46.00	0.60	157	28	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

Table 11 - Radiated Emissions Peak Detector Measurements, Low Channel, 1-26 GHz, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol	Mode
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		802.11
2412.000000	103.51	NA	NA	224	194	HORI	b
4824.000000	55.15	74.00	18.85	200	50	VERT	b
2414.500000	103.28	NA	NA	248	194	HORI	g
4823.800000	43.10	74.00	30.90	241	172	VERT	g
2410.500000	102.92	NA	NA	177	184	HORI	n
4825.200000	49.39	74.00	24.61	210	243	VERT	n
No signals detected above system sensitivity							

Table 12 - Radiated Emissions Average Detector Measurements, Low Channel, 1-26 GHz, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol	Mode
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		802.11
2412.000000	98.77	NA	NA	224	194	HORI	b
4824.000000	52.38	54.00	1.62	200	50	VERT	b
2412.000000	88.25	NA	NA	248	194	HORI	g
4823.800000	29.70	54.00	24.30	241	172	VERT	g
2412.000000	86.79	NA	NA	177	184	HORI	n
4825.200000	31.85	54.00	22.15	210	243	VERT	n
No signals detected above system sensitivity							

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

Table 13 - Radiated Emissions Peak Measurements, Middle Channel, 1-26 GHz, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol	Mode
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.		802.11
2438.000000	104.88	NA	NA	224	194	HORI	b
4874.000000	52.23	74.00	21.77	224	246	VERT	b
2440.000000	108.70	NA	NA	234	194	HORI	g
4876.200000	50.42	74.00	23.58	221	246	VERT	g
2439.000000	107.27	NA	NA	244	184	HORI	n
4881.400000	44.46	74.00	29.54	278	355	VERT	n

Table 14 - Radiated Emissions Average Measurements, Middle Channel, 1-26 GHz, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol	Mode
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.		802.11
2437.000000	100.11	NA	NA	224	194	HORI	b
4874.000000	41.22	54.00	12.78	224	246	VERT	b
2437.000000	93.55	NA	NA	234	194	HORI	g
4876.200000	33.19	54.00	20.81	221	246	VERT	g
2437.000000	90.61	NA	NA	244	184	HORI	n
4881.400000	31.13	54.00	22.87	278	355	VERT	n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

Table 15 - Radiated Emissions Peak Measurements, High Channel, 1-26 GHz, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol	Mode
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		802.11
2461.000000	97.36	NA	NA	221	194	HORI	b
4924.000000	50.35	74.00	23.65	200	216	VERT	b
2463.500000	103.05	NA	NA	231	184	HORI	g
4920.400000	47.05	74.00	26.95	319	253	HORI	g
2463.000000	104.11	NA	NA	211	194	HORI	n
4925.200000	46.38	74.00	27.62	255	235	VERT	n
No signals detected above system sensitivity							

Table 16 - Radiated Emissions Average Measurements, High Channel, 1-26 GHz, 12" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol	Mode
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		802.11
2462.000000	92.41	NA	NA	221	194	HORI	b
4924.000000	38.90	54.00	15.10	200	216	VERT	b
2462.000000	88.44	NA	NA	231	184	HORI	g
4920.400000	30.80	54.00	23.20	319	253	HORI	g
2462.000000	87.76	NA	NA	211	194	HORI	n
4925.200000	30.10	54.00	23.90	255	235	VERT	n
No signals detected above system sensitivity							

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. All 3 possible 802.11 modes were tested. The highest of each is presented in the tables.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

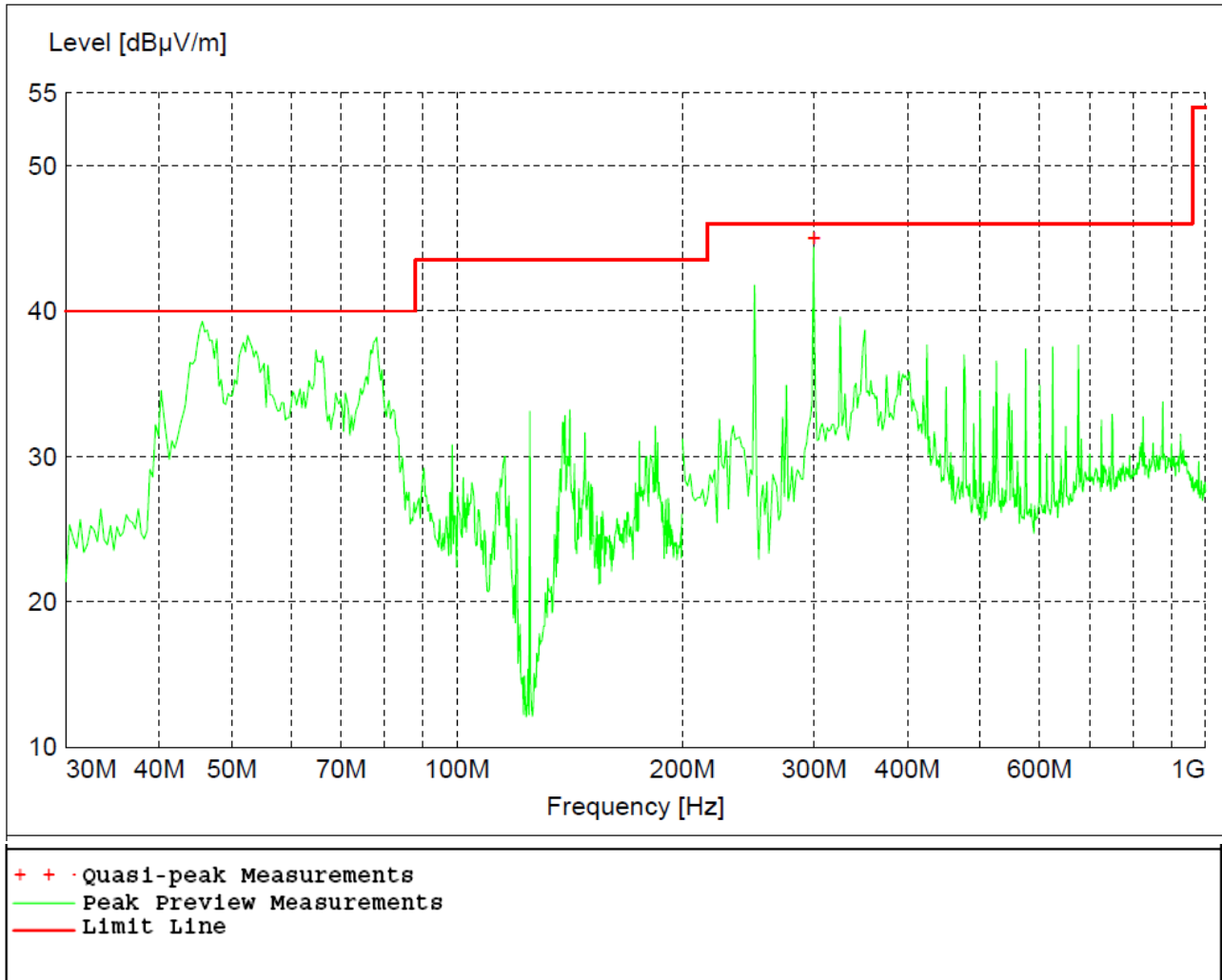


Figure 12 - Radiated Emissions Plot, Receive

Table 17 - Radiated Emissions Quasi-peak and Peak Measurements, Receive, 10" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
300.000000	45.02	46.00	1.00	100	236	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

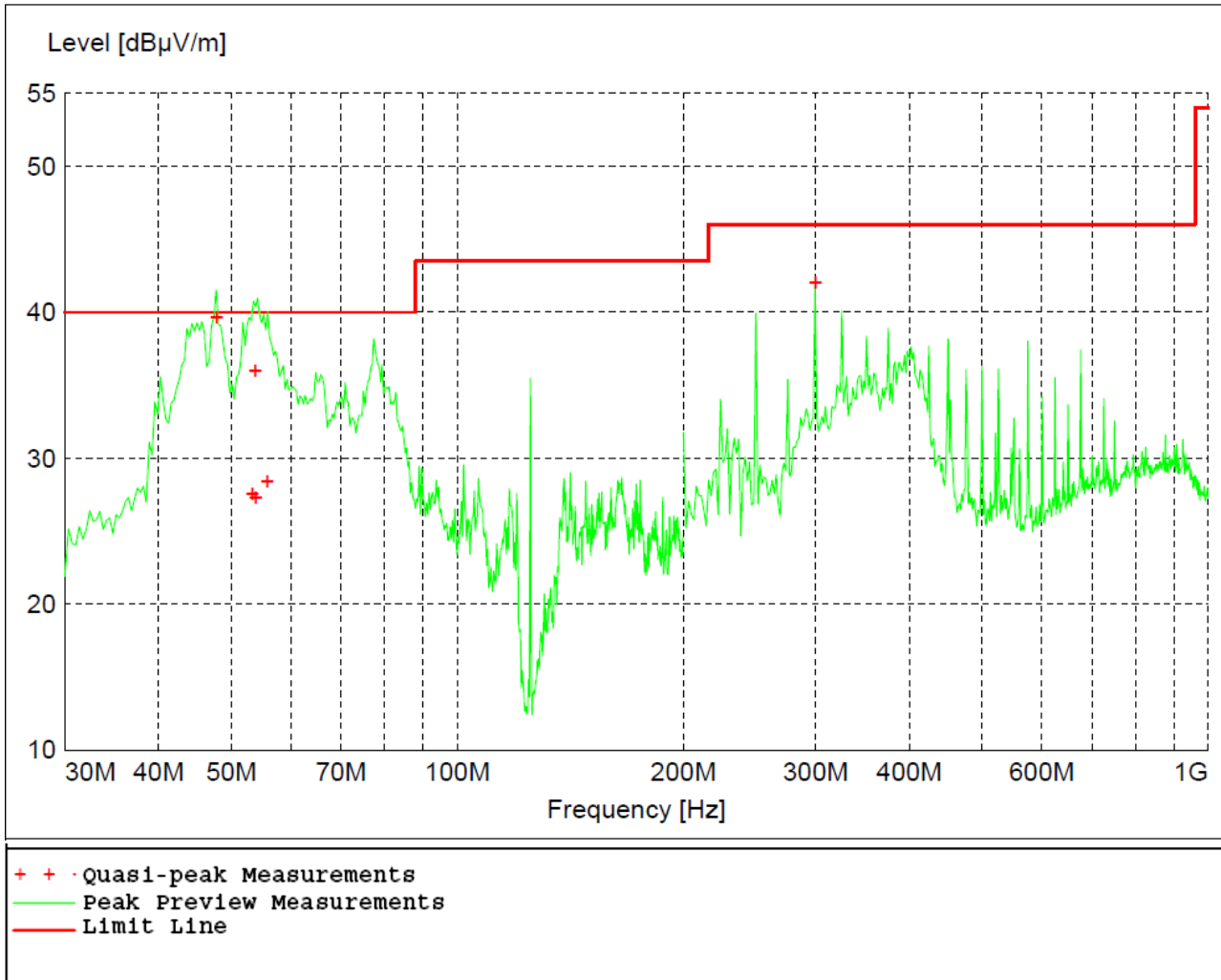


Figure 13 - Radiated Emissions Plot, Low Channel

Table 18 - Radiated Emissions Quasi-peak Measurements, Low Channel, 802.11b, 10" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
47.820000	39.69	40.00	0.30	100	189	VERT
53.340000	27.59	40.00	12.40	397	359	VERT
53.820000	35.96	40.00	4.00	100	250	VERT
53.880000	27.32	40.00	12.70	99	266	VERT
55.860000	28.46	40.00	11.50	100	276	VERT
300.000000	42.01	46.00	4.00	103	236	HORI

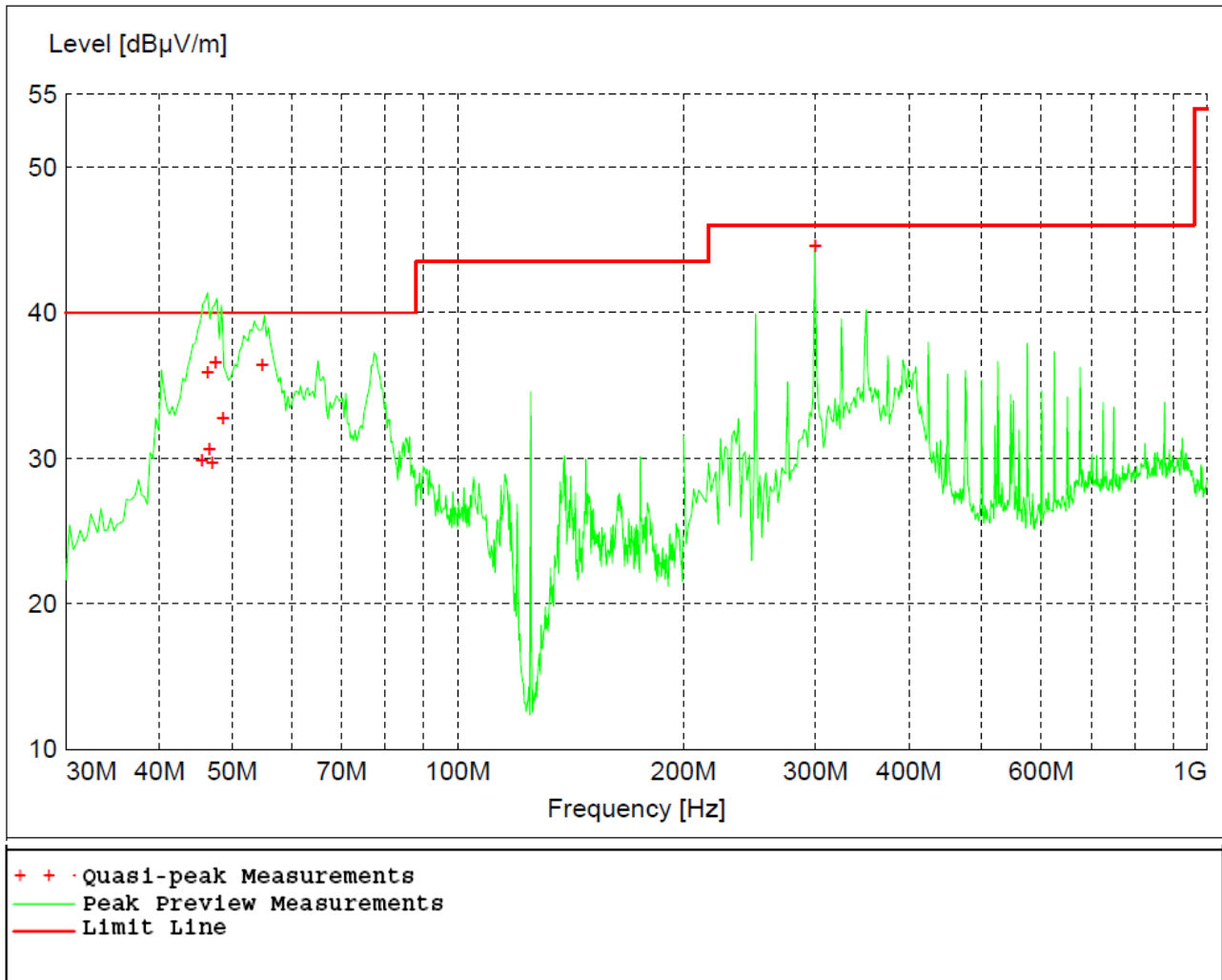


Figure 14 - Radiated Emissions Plot, Mid Channel

Table 19 - Radiated Emissions Quasi-peak Measurements, Mid Channel, 802.11b, 10" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
45.600000	29.90	40.00	10.10	99	180	VERT
46.380000	35.90	40.00	4.10	100	321	VERT
46.620000	30.62	40.00	9.40	101	97	VERT
47.040000	29.68	40.00	10.30	163	4	VERT
47.520000	36.57	40.00	3.40	100	255	VERT
48.660000	32.79	40.00	7.20	101	38	VERT
54.840000	36.41	40.00	3.60	99	228	VERT
300.000000	44.63	46.00	1.40	100	223	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

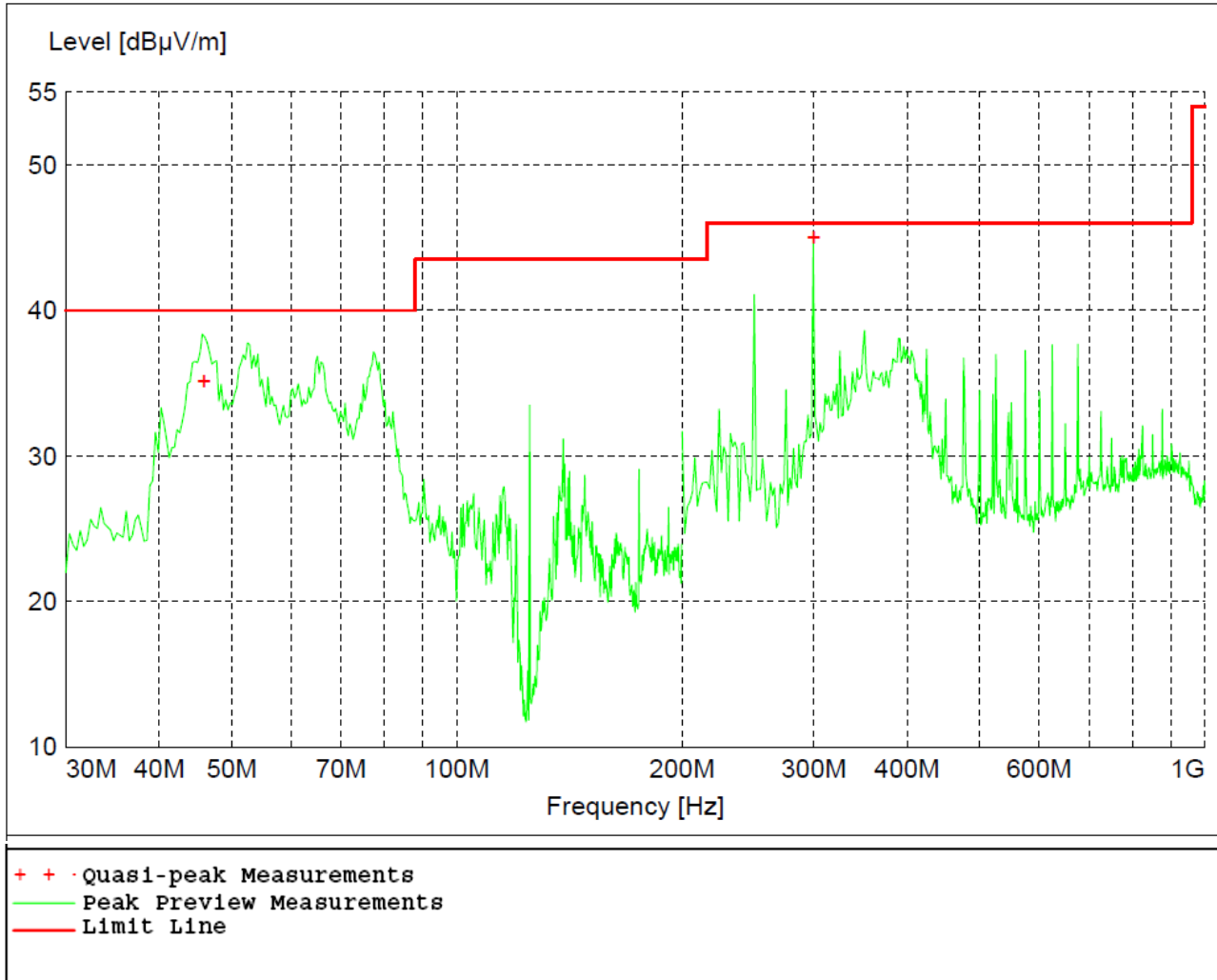


Figure 15 - Radiated Emissions Plot, High Channel

Table 20 - Radiated Emissions Quasi-peak Measurements, High Channel, 802.11b, 10" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
45.960000	35.17	40.00	4.80	100	275	VERT
300.000000	44.99	46.00	1.00	100	231	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

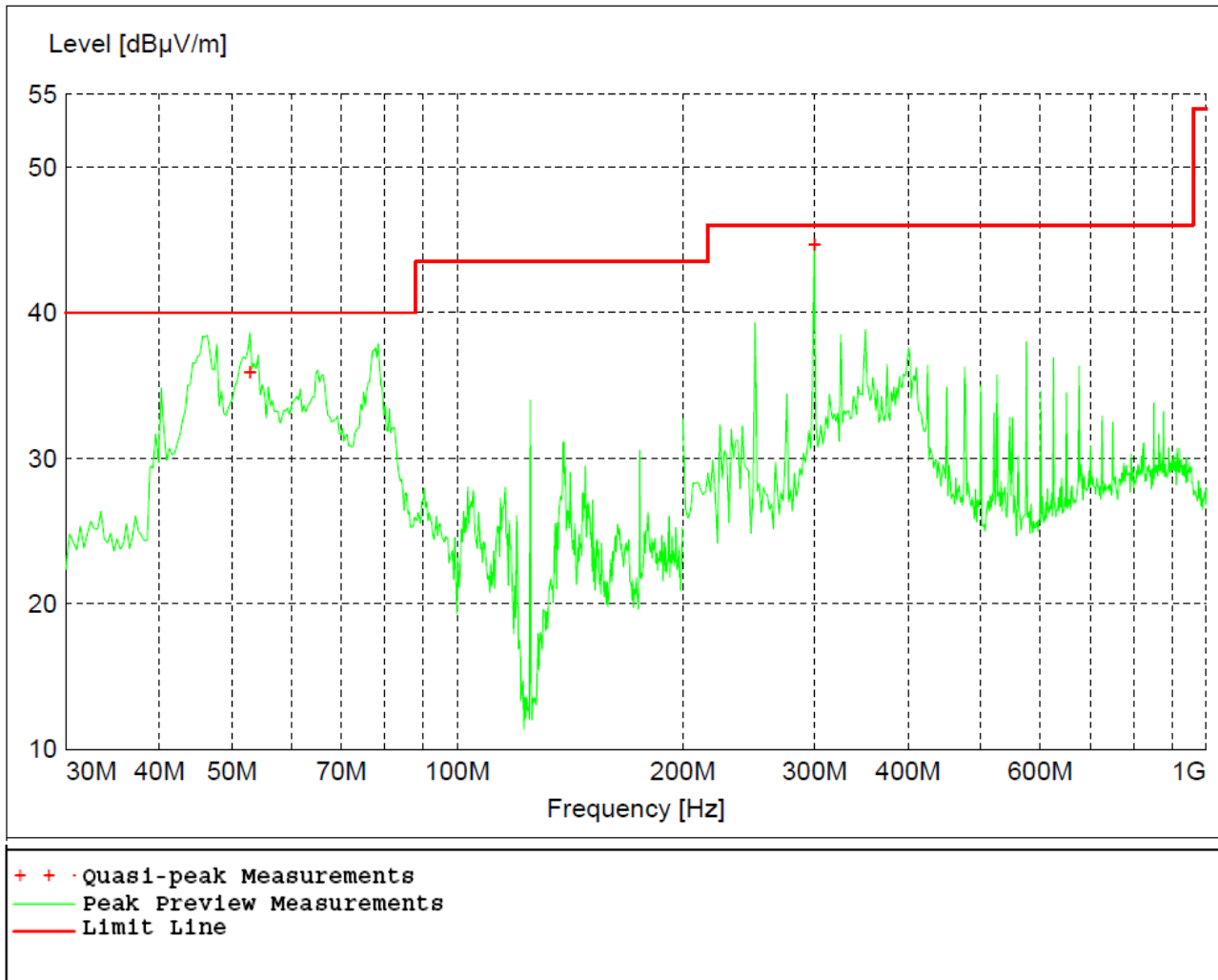


Figure 16 - Radiated Emissions Plot, Low Channel

Table 21 - Radiated Emissions Quasi-peak Measurements, Low Channel, 802.11g, 10" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
52.860000	35.89	40.00	4.10	100	297	VERT
300.000000	44.72	46.00	1.30	99	226	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

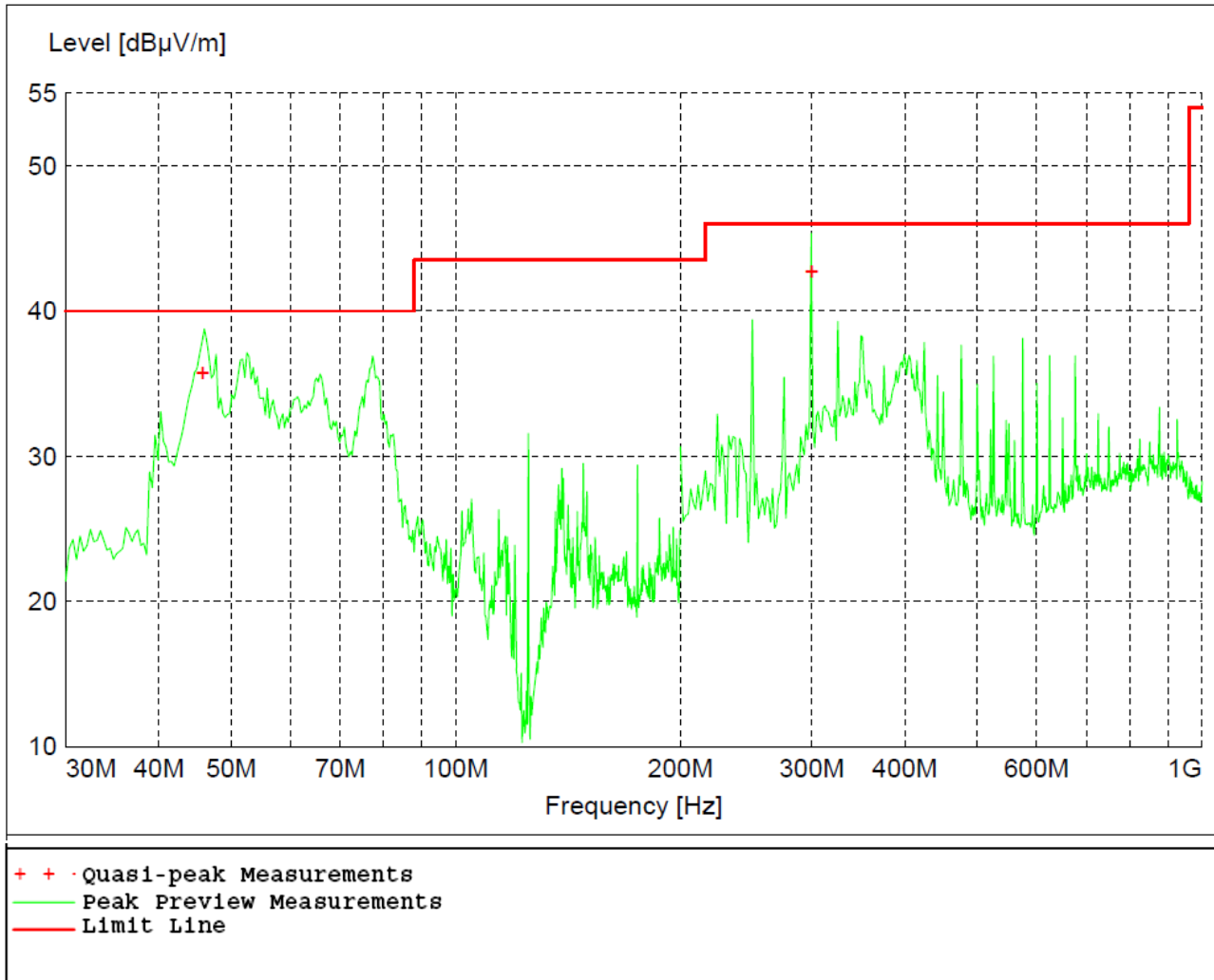


Figure 17 - Radiated Emissions Plot, Mid Channel

Table 22 - Radiated Emissions Quasi-peak Measurements, Mid Channel, 802.11g, 10" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
45.840000	35.74	40.00	4.30	100	0	VERT
300.000000	42.72	46.00	3.30	99	231	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

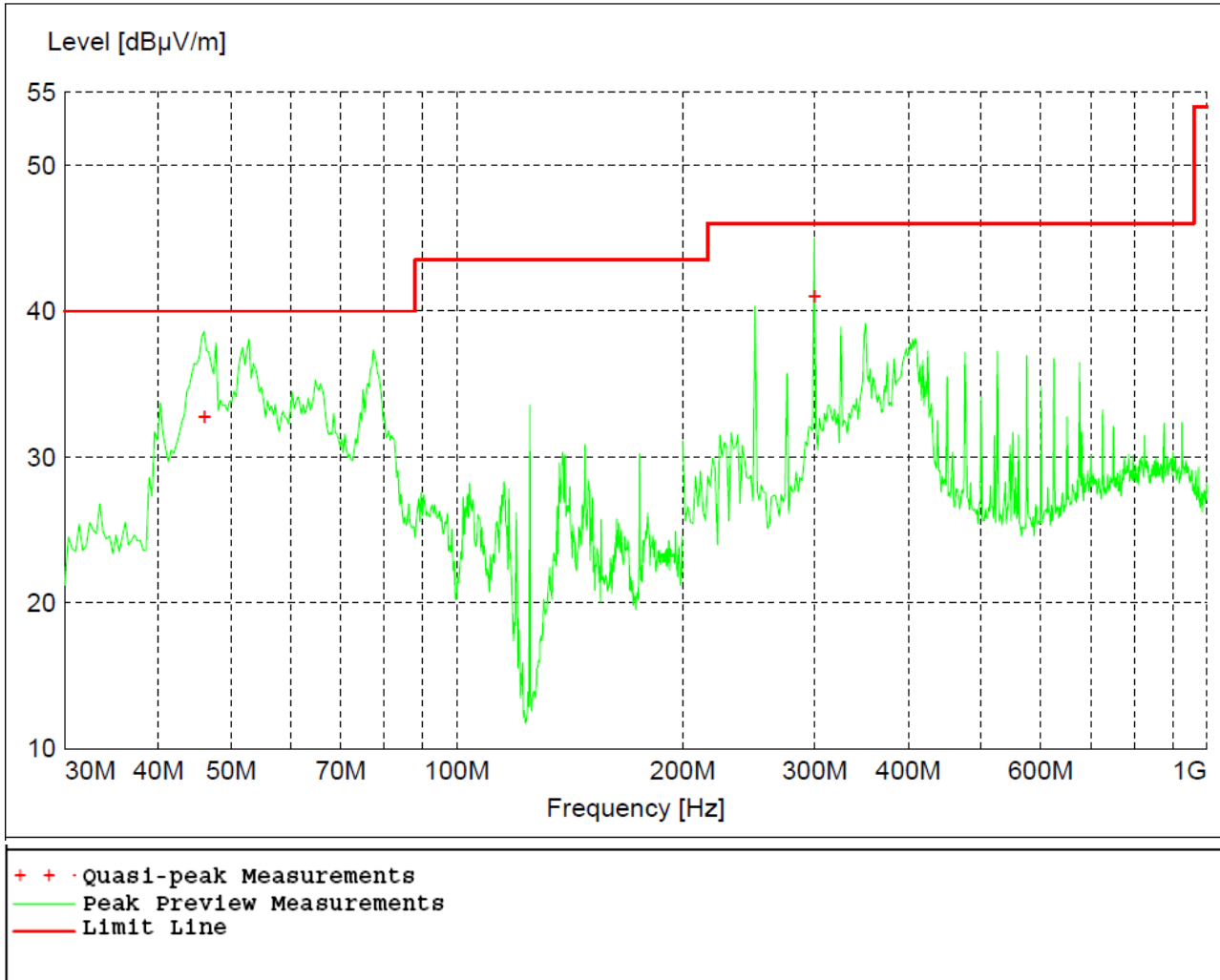


Figure 18 - Radiated Emissions Plot, High Channel

Table 23 - Radiated Emissions Quasi-peak Measurements, High Channel, 802.11g, 10" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
46.140000	32.78	40.00	7.20	103	80	VERT
300.000000	41.05	46.00	4.90	100	228	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

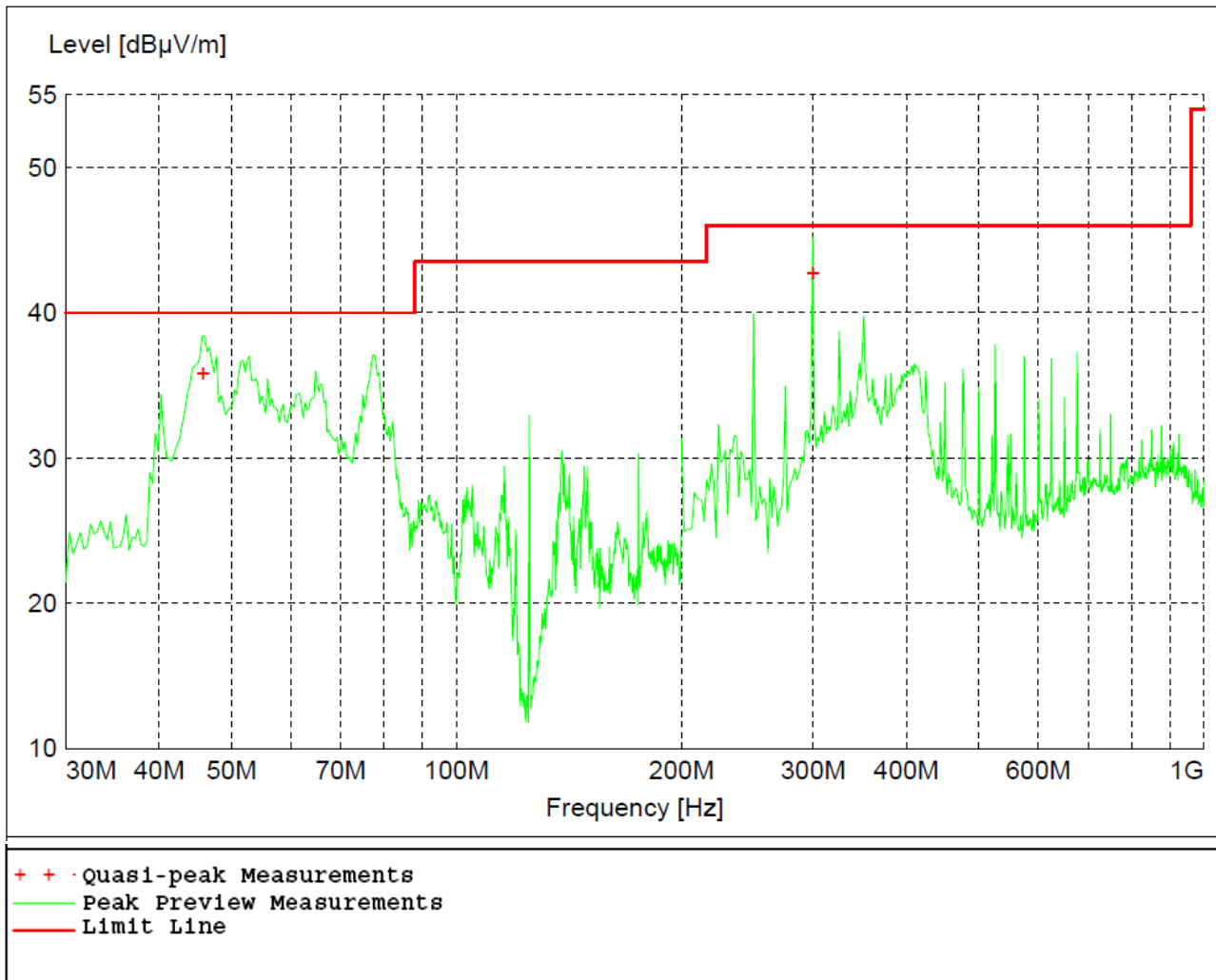


Figure 19 - Radiated Emissions Plot, Low Channel

Table 24 - Radiated Emissions Quasi-peak Measurements, Low Channel, 802.11n, 10" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
45.840000	35.87	40.00	4.10	100	182	VERT
300.000000	42.69	46.00	3.30	113	228	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

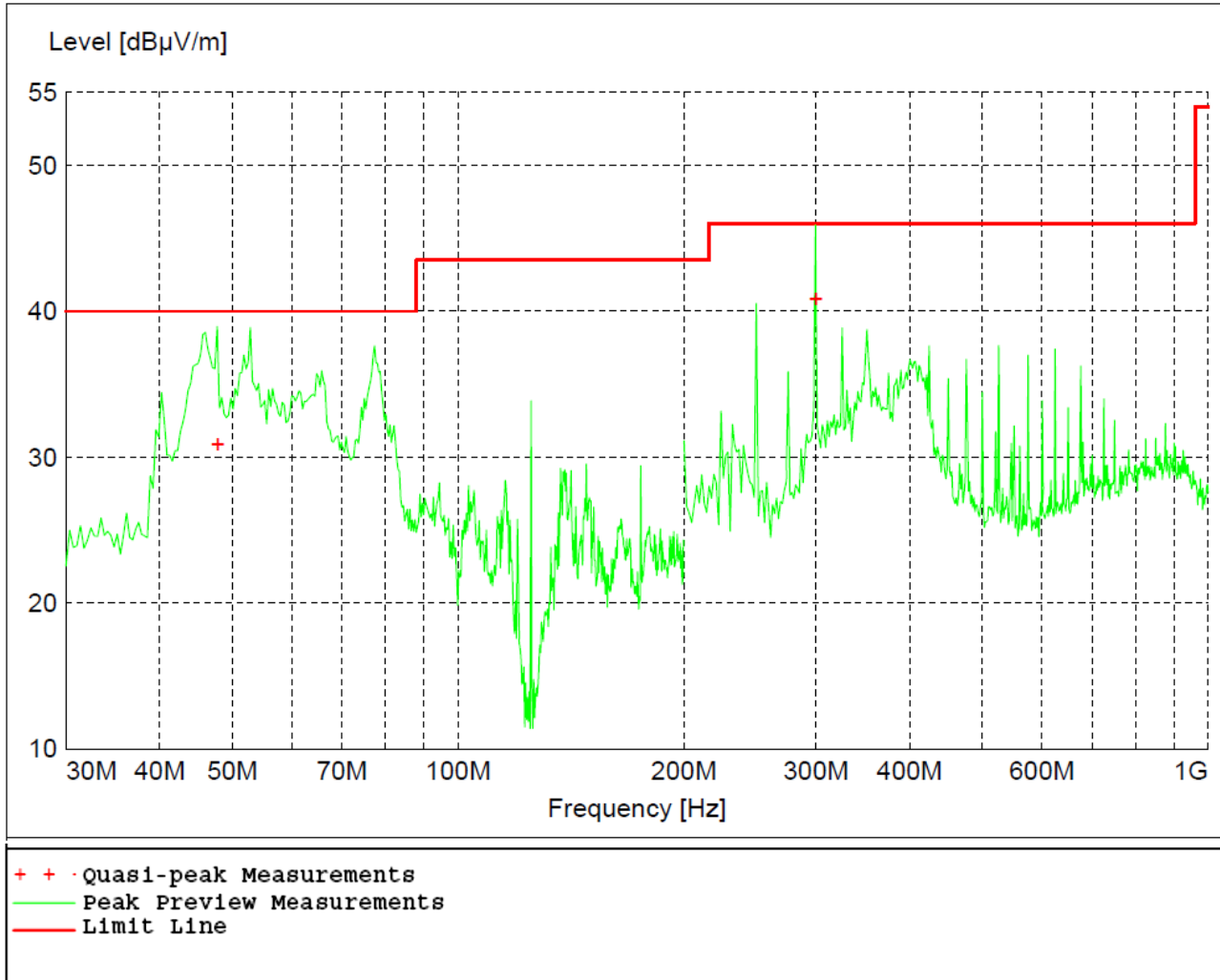


Figure 20 - Radiated Emissions Plot, Mid Channel

Table 25 - Radiated Emissions Quasi-peak Measurements, Mid Channel, 802.11n, 10" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
47.820000	30.94	40.00	9.10	100	46	VERT
300.000000	40.89	46.00	5.10	102	236	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

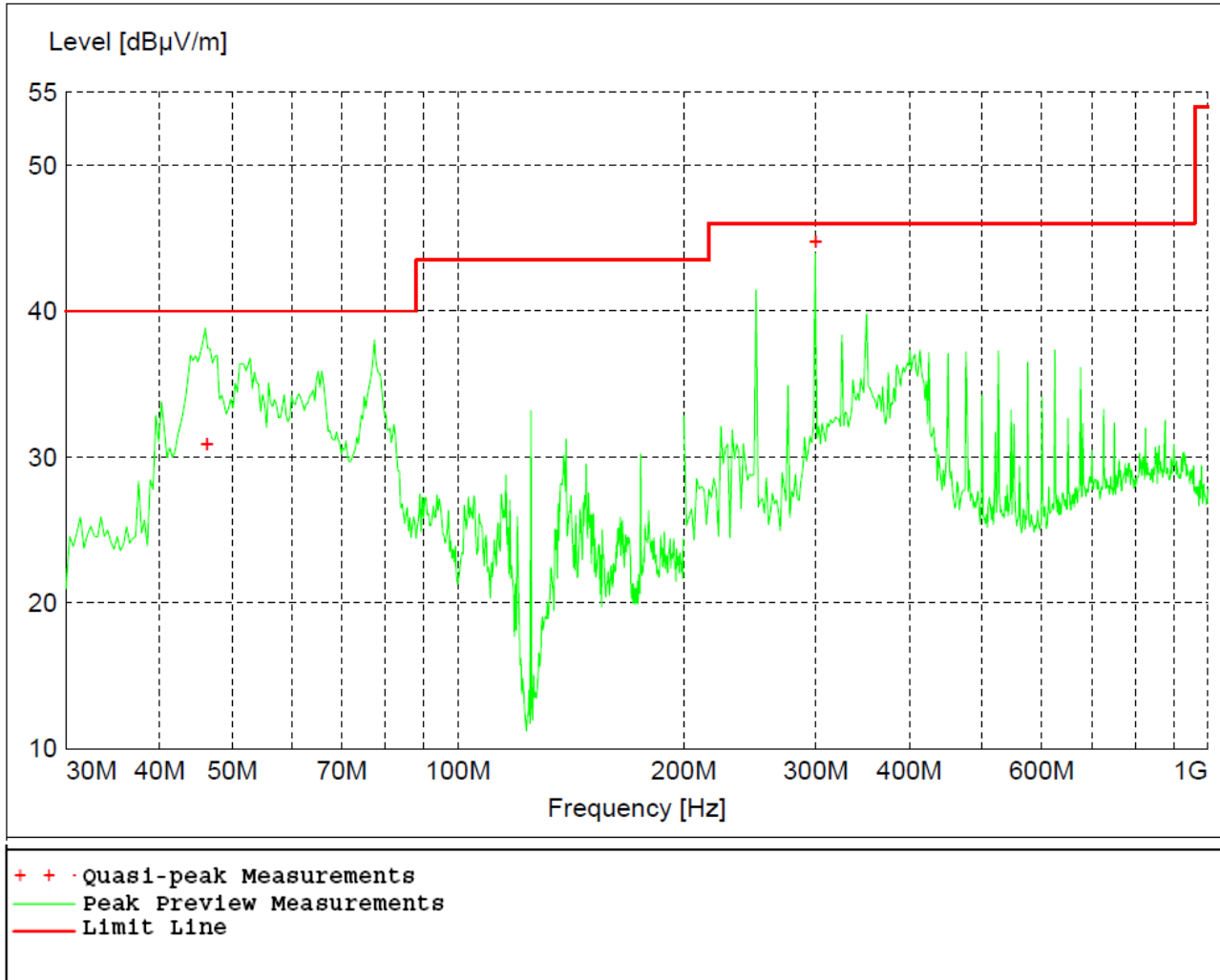


Figure 21 - Radiated Emissions Plot, High Channel

Table 26 - Radiated Emissions Quasi-peak Measurements, High Channel, 802.11n, 10" unit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBμV/m	dBμV/m	dB	cm.	deg.	
46.260000	30.91	40.00	9.10	100	131	VERT
300.000000	44.80	46.00	1.20	99	236	HORI

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

4.3 PEAK OUTPUT POWER

Test Method: ANSI C63.10:
1. Section(s) 11.9.2.2.2

Limits of power measurements:
The maximum allowed peak output power is 30 dBm.

Test procedures:
The EUT was connected to an RF power meter directly with a low-loss shielded coaxial cable with 10 MHz RBW and 10 MHz VBW. The intention was to verify that the measurement results were the same as the original filing for this device within the measurement uncertainty of the laboratory.

Deviations from test standard:
No deviation.

Test setup:

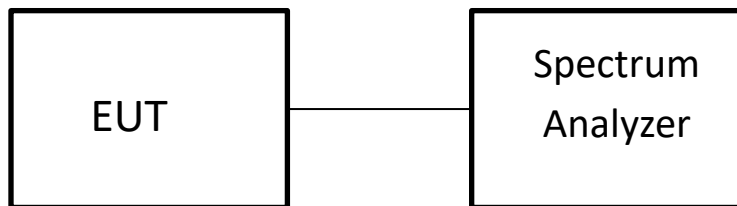


Figure 22 – Peak Output Power Measurements Test Setup

EUT operating conditions:
The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

Test results:

The uncertainty for conducted peak power measurements is ± 1.1 dB and average power is ± 1.37 dB

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

Peak Output Power

CHANNEL	CHANNEL FREQUENCY (MHz)	WIFI Type	PEAK OUTPUT POWER (dBm) MU = ± 1.1 dB	Method	RESULT
Low	2412	802.11b	24.37	Conducted	PASS
Middle	2437	802.11b	23.52	Conducted	PASS
High	2462	802.11b	23.77	Conducted	PASS
Low	2412	802.11g	20.74	Conducted	PASS
Middle	2437	802.11g	23.47	Conducted	PASS
High	2462	802.11g	20.51	Conducted	PASS
Low	2412	802.11n	20.50	Conducted	PASS
Middle	2437	802.11n	23.14	Conducted	PASS
High	2462	802.11n	19.95	Conducted	PASS

Average Output Power

CHANNEL	CHANNEL FREQUENCY (MHz)	WIFI Type	Average OUTPUT POWER (dBm) MU = ± 1.37	Method	RESULT
Low	2412	802.11b	17.66	Conducted	PASS
Middle	2437	802.11b	17.11	Conducted	PASS
High	2462	802.11b	16.96	Conducted	PASS
Low	2412	802.11g	15.06	Conducted	PASS
Middle	2437	802.11g	17.60	Conducted	PASS
High	2462	802.11g	14.07	Conducted	PASS
Low	2412	802.11n	15.83	Conducted	PASS
Middle	2437	802.11n	17.55	Conducted	PASS
High	2462	802.11n	14.09	Conducted	PASS

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

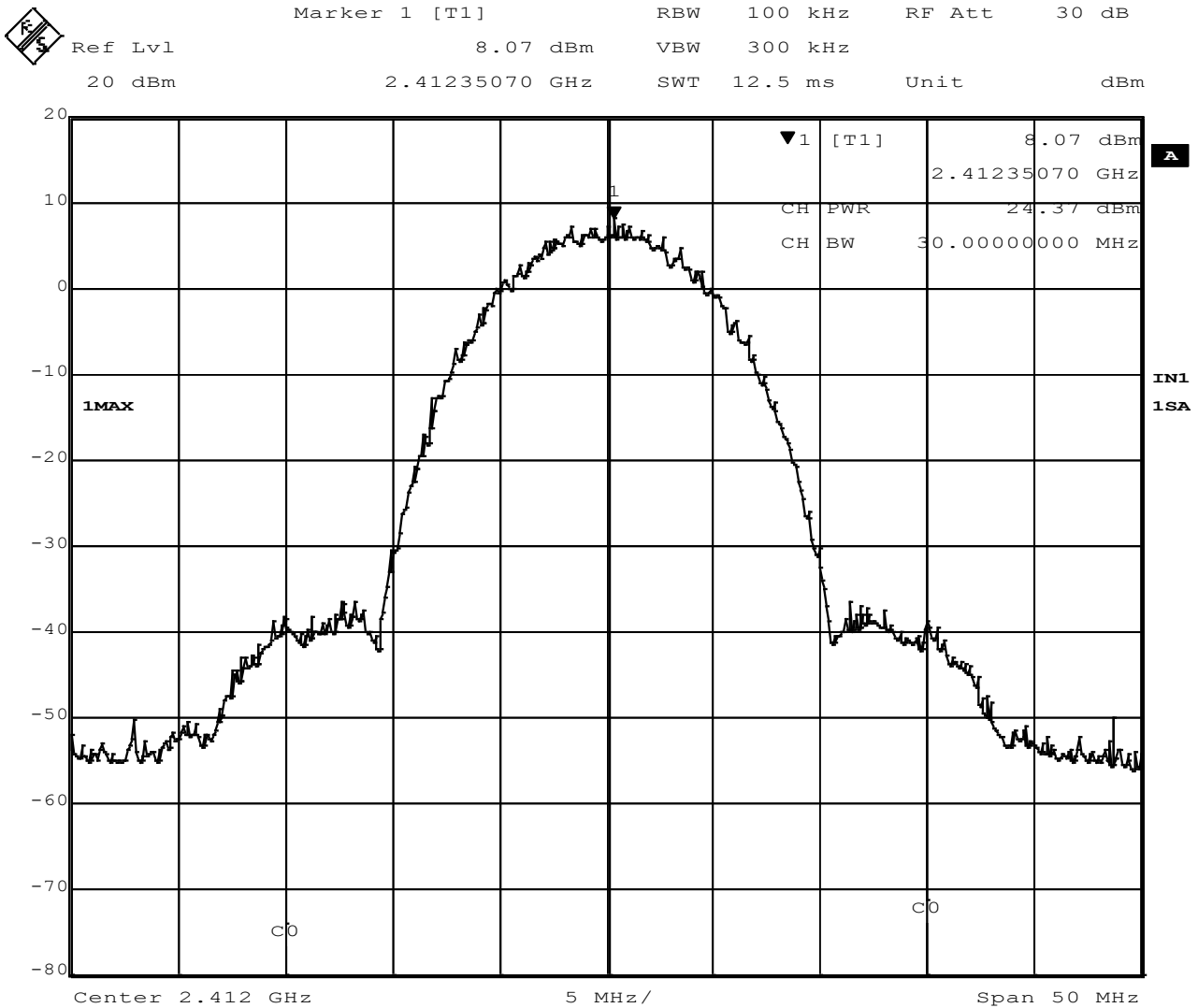


Figure 23 – Peak Power Measurement, Low Channel, 802.11b

Worst case was determined to be 1 Mbps for 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

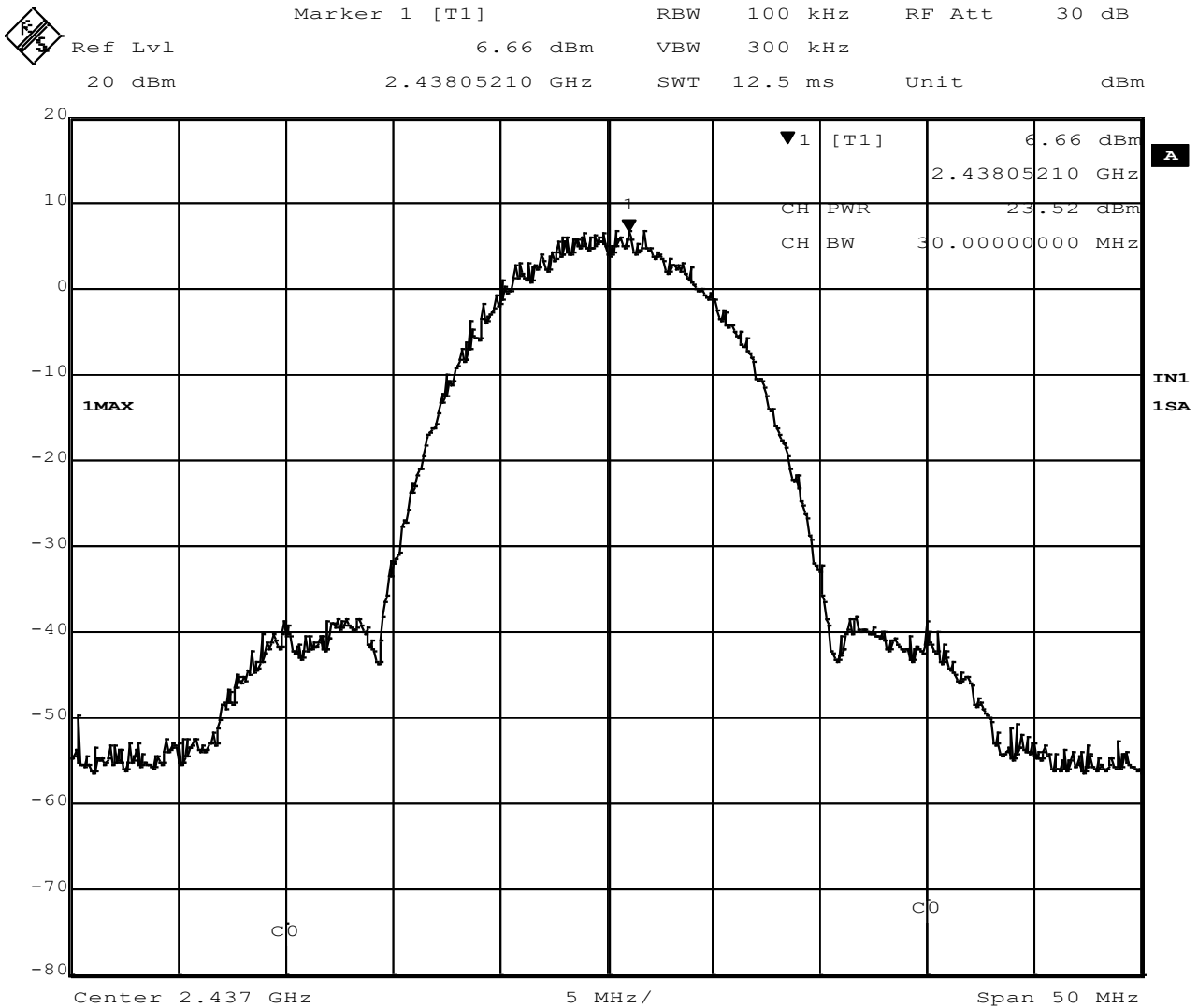


Figure 24 - Peak Power Measurement, Mid Channel, 802.11b

Worst case was determined to be 1 Mbps for 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

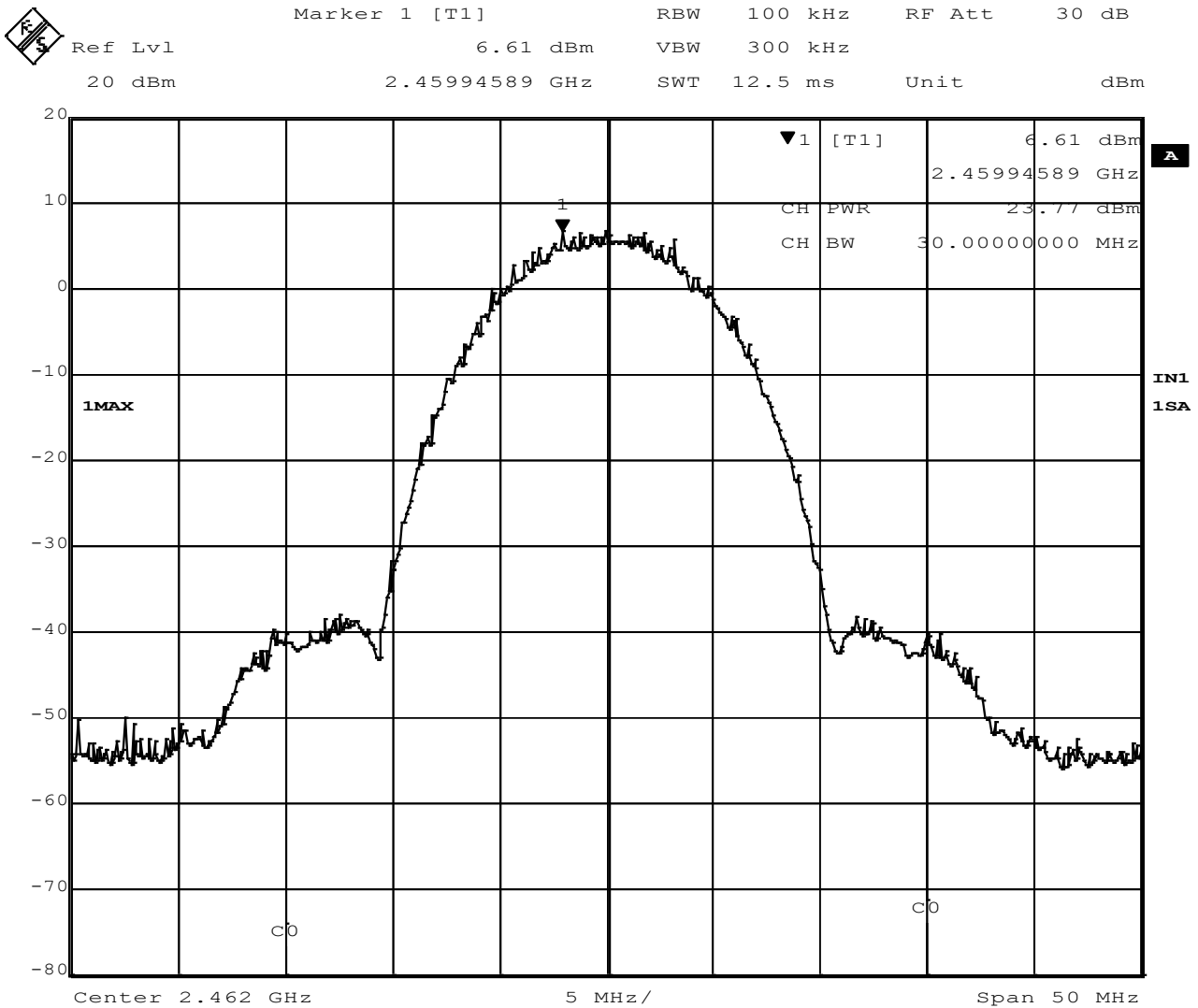


Figure 25 - Peak Power Measurement, High Channel, 802.11b

Worst case was determined to be 1 Mbps for 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

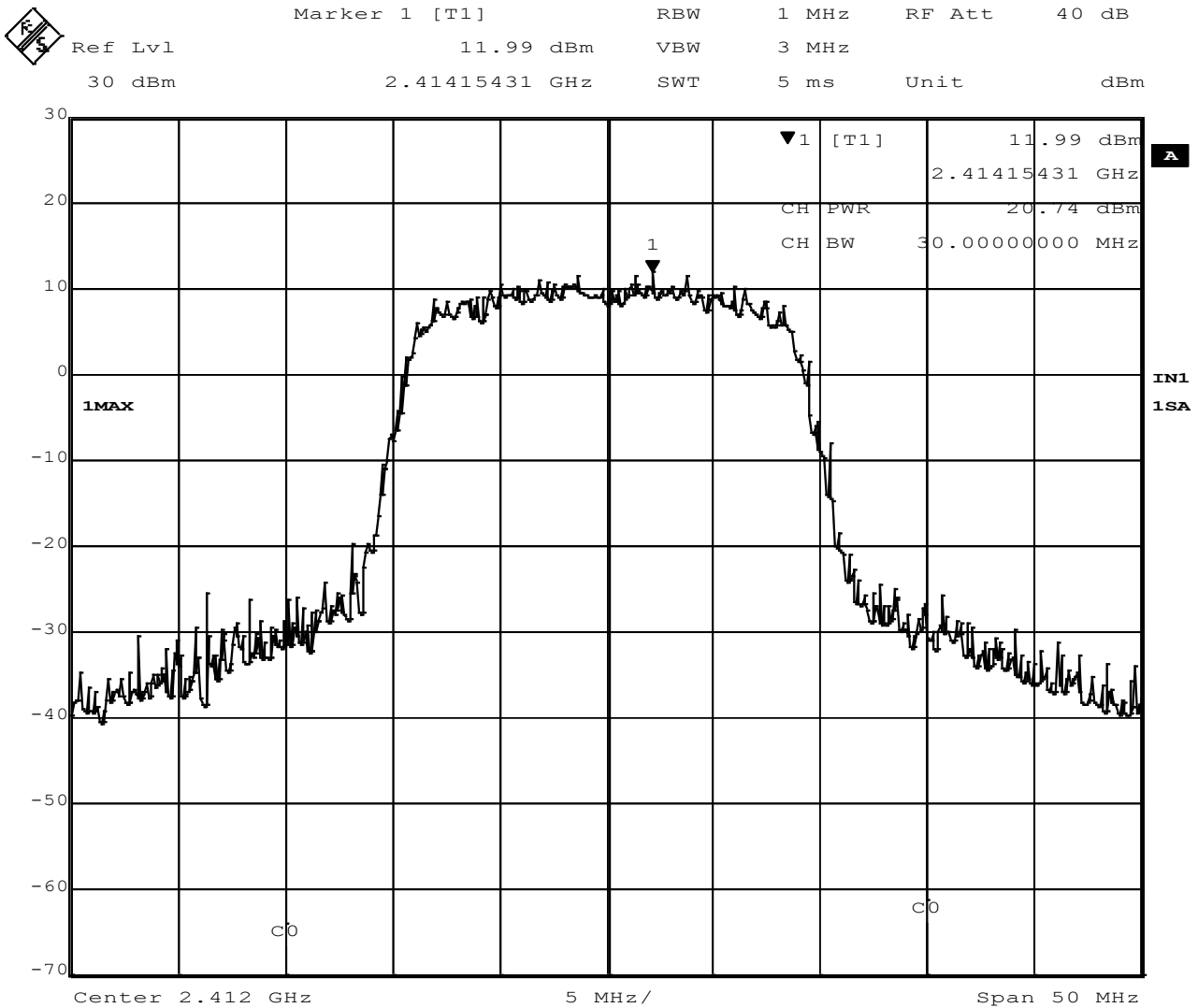


Figure 26 – Peak Power Measurement, Low Channel, 802.11g

Worst case was determined to be 65 Mbps for 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

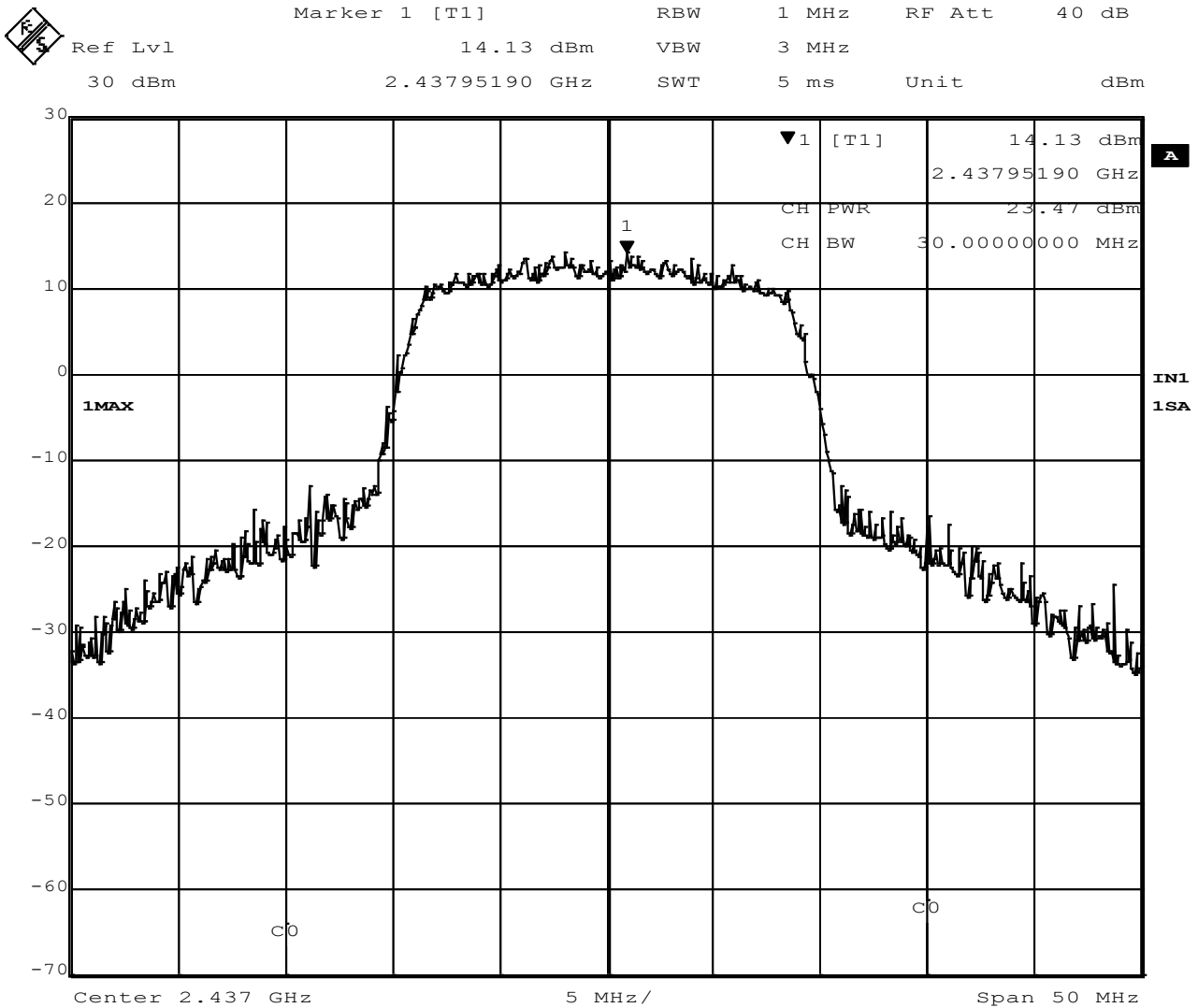


Figure 27 - Peak Power Measurement, Mid Channel, 802.11g

Worst case was determined to be 65 Mbps for 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

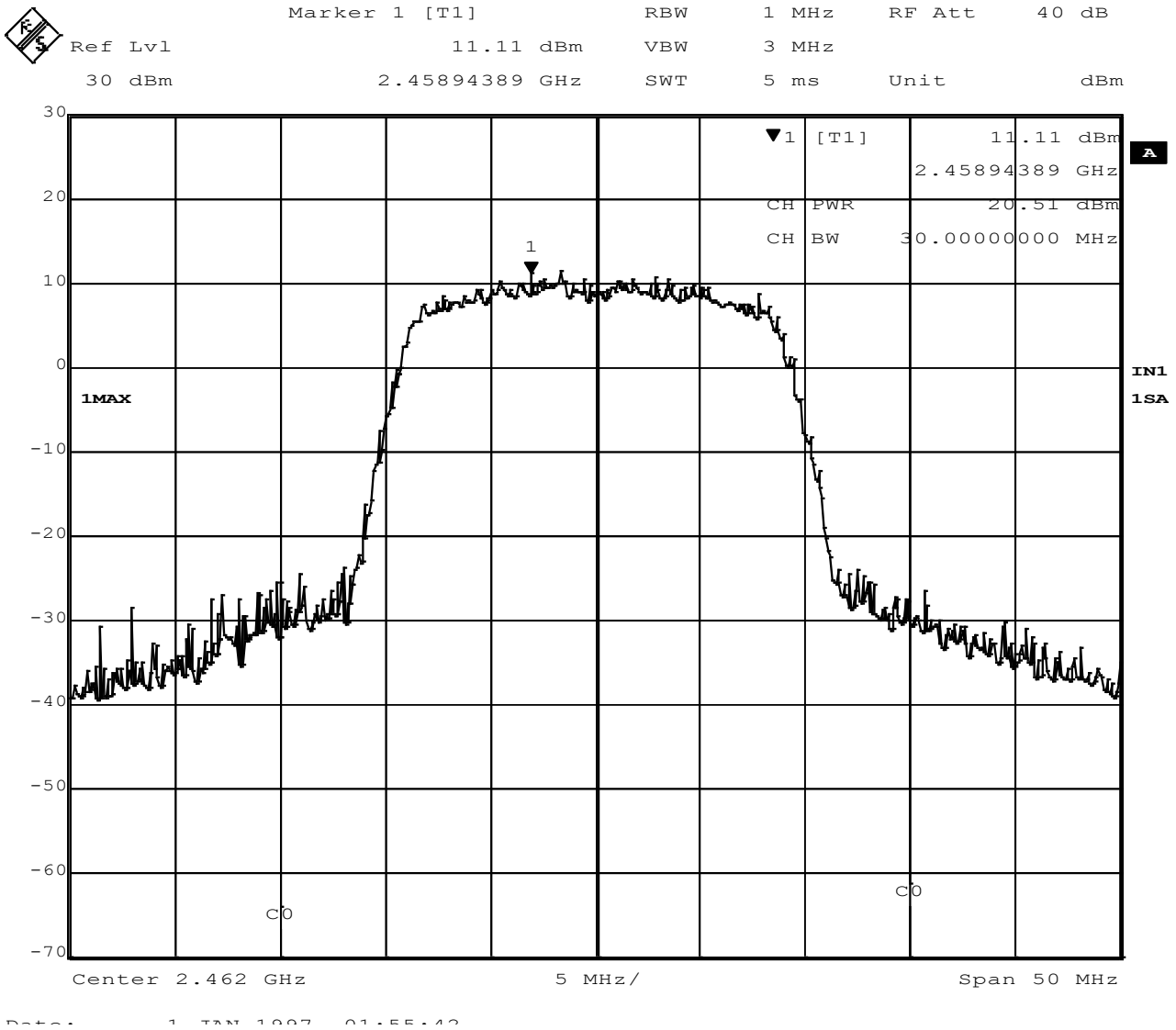


Figure 28 - Peak Power Measurement, High Channel, 802.11g

Worst case was determined to be 65 Mbps for 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

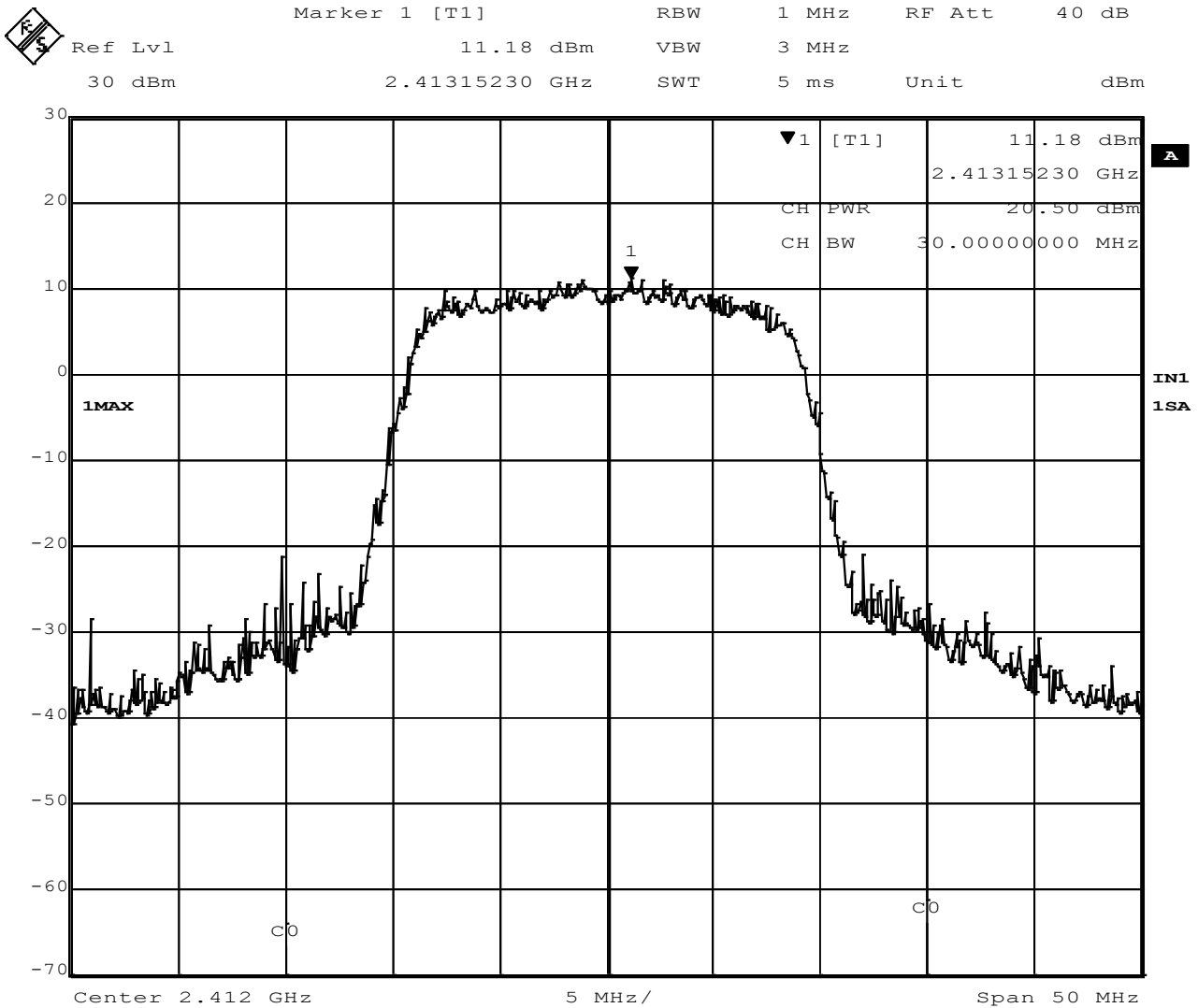


Figure 29 – Peak Power Measurement, Low Channel, 802.11n

Worst case was determined to be MSC7 for 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

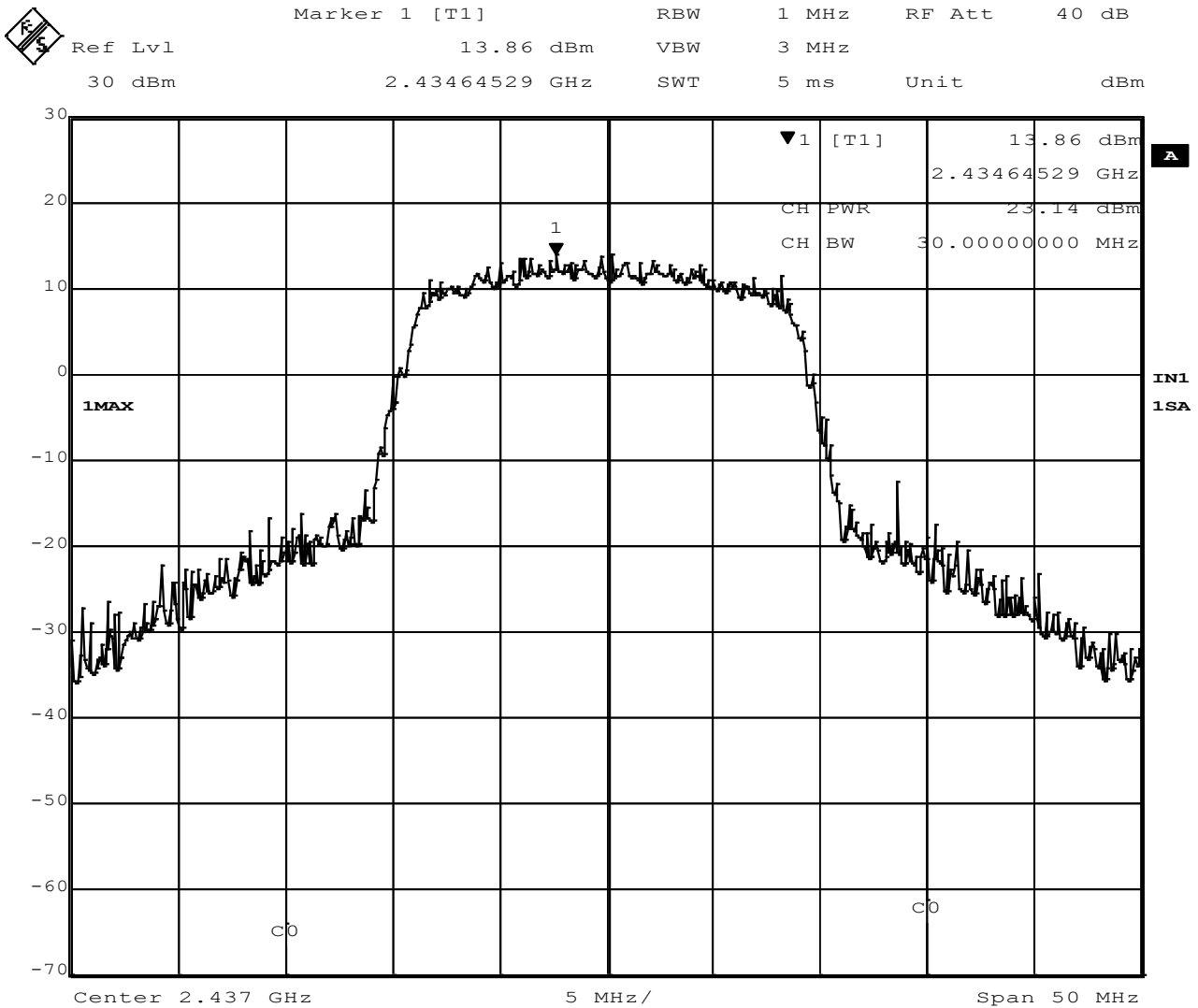


Figure 30 - Peak Power Measurement, Mid Channel, 802.11n

Worst case was determined to be MSC7 for 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

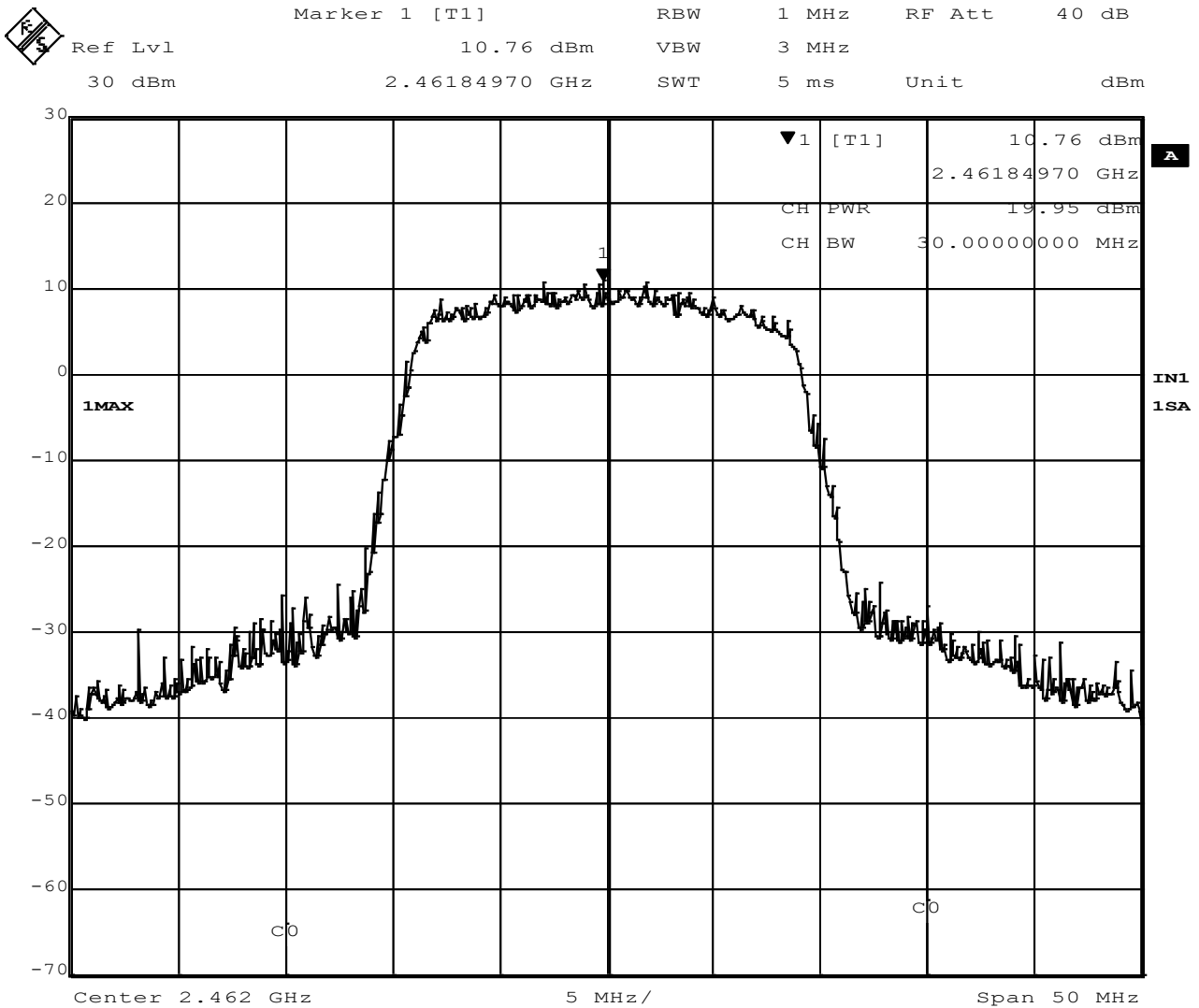


Figure 31 - Peak Power Measurement, High Channel, 802.11n

Worst case was determined to be MSC7 for 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

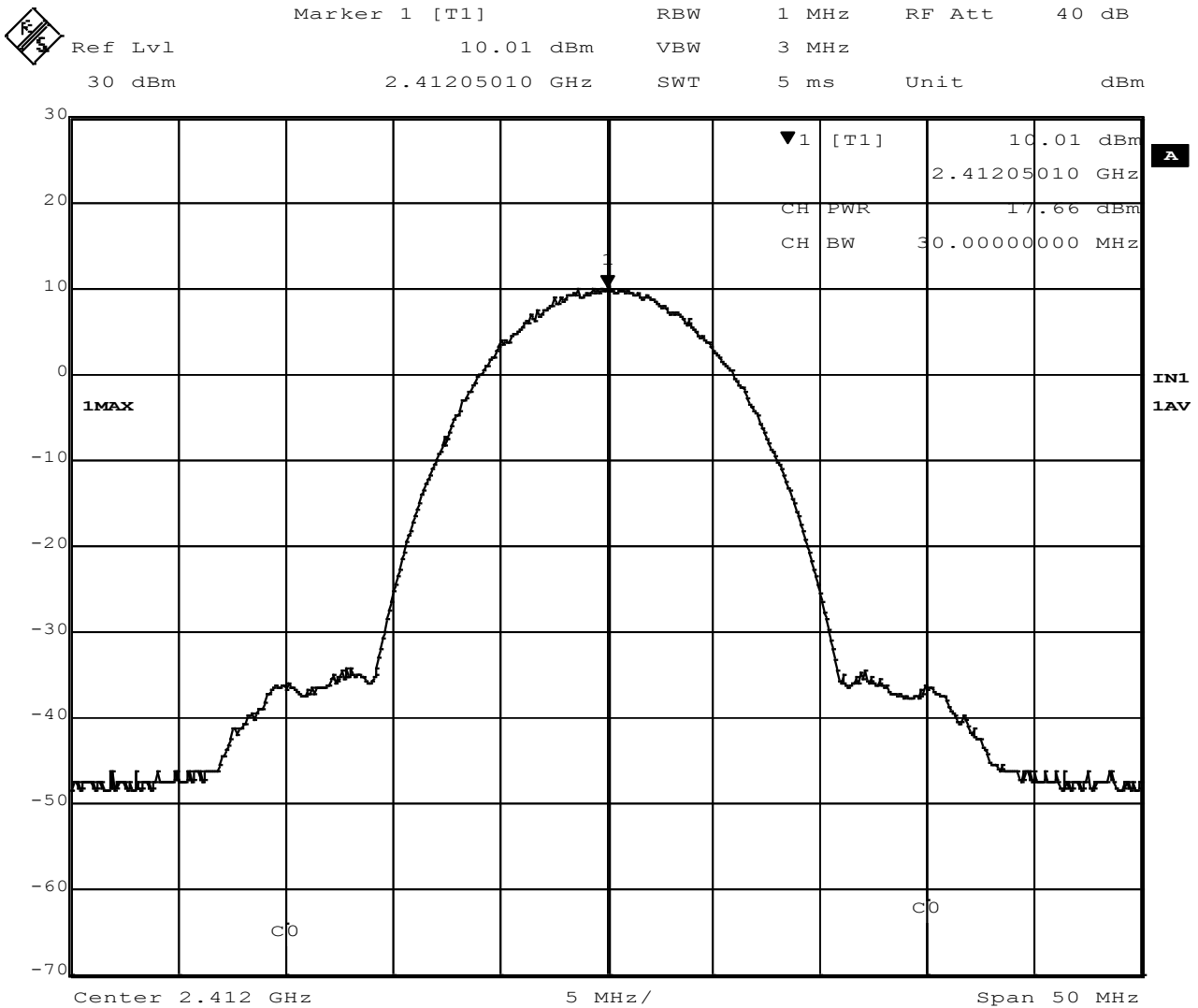


Figure 32 – Average Power Measurement, Low Channel, 802.11b

Worst case was determined to be 1 Mbps for 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

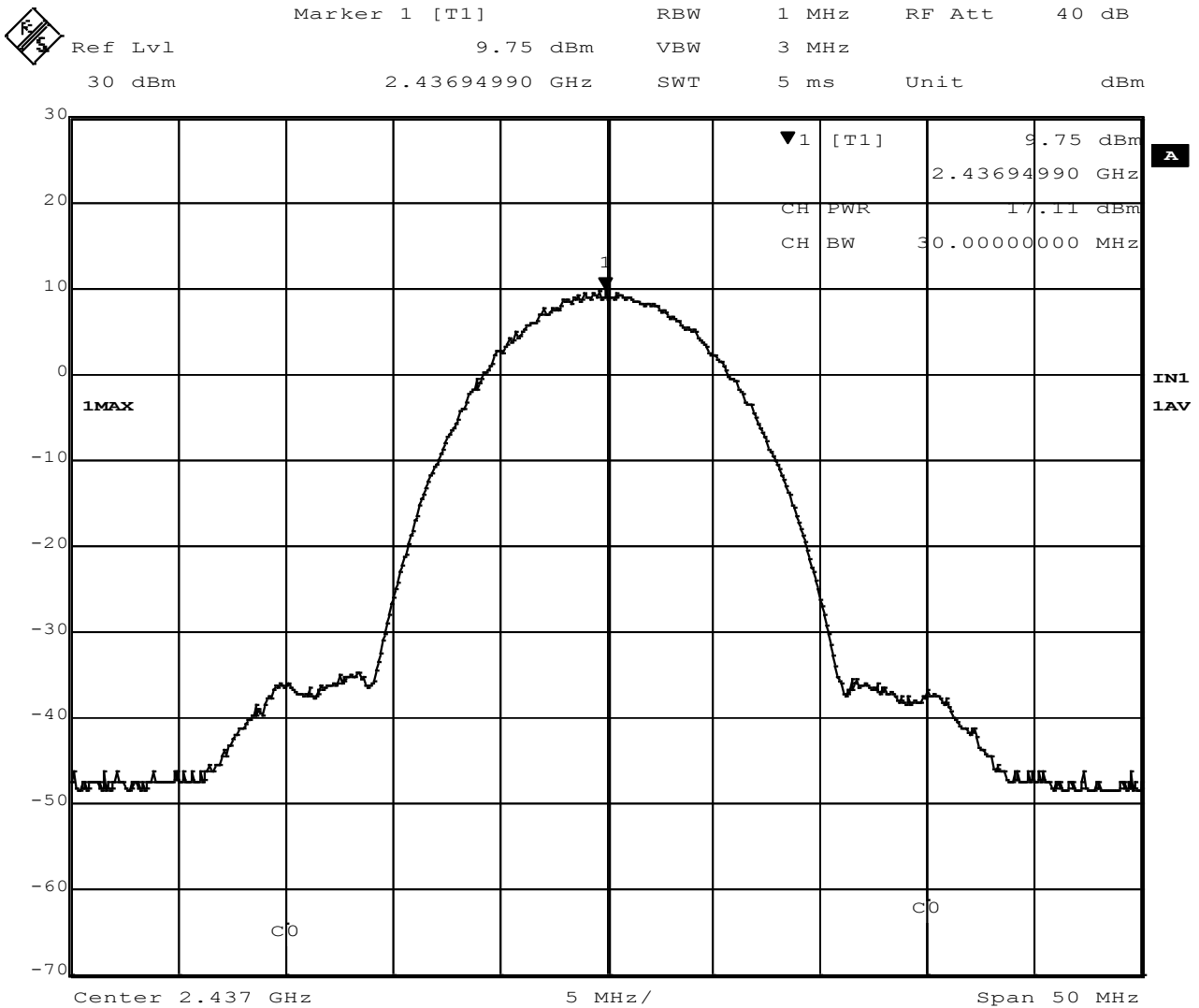


Figure 33 - Average Power Measurement, Mid Channel, 802.11b

Worst case was determined to be 1 Mbps for 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

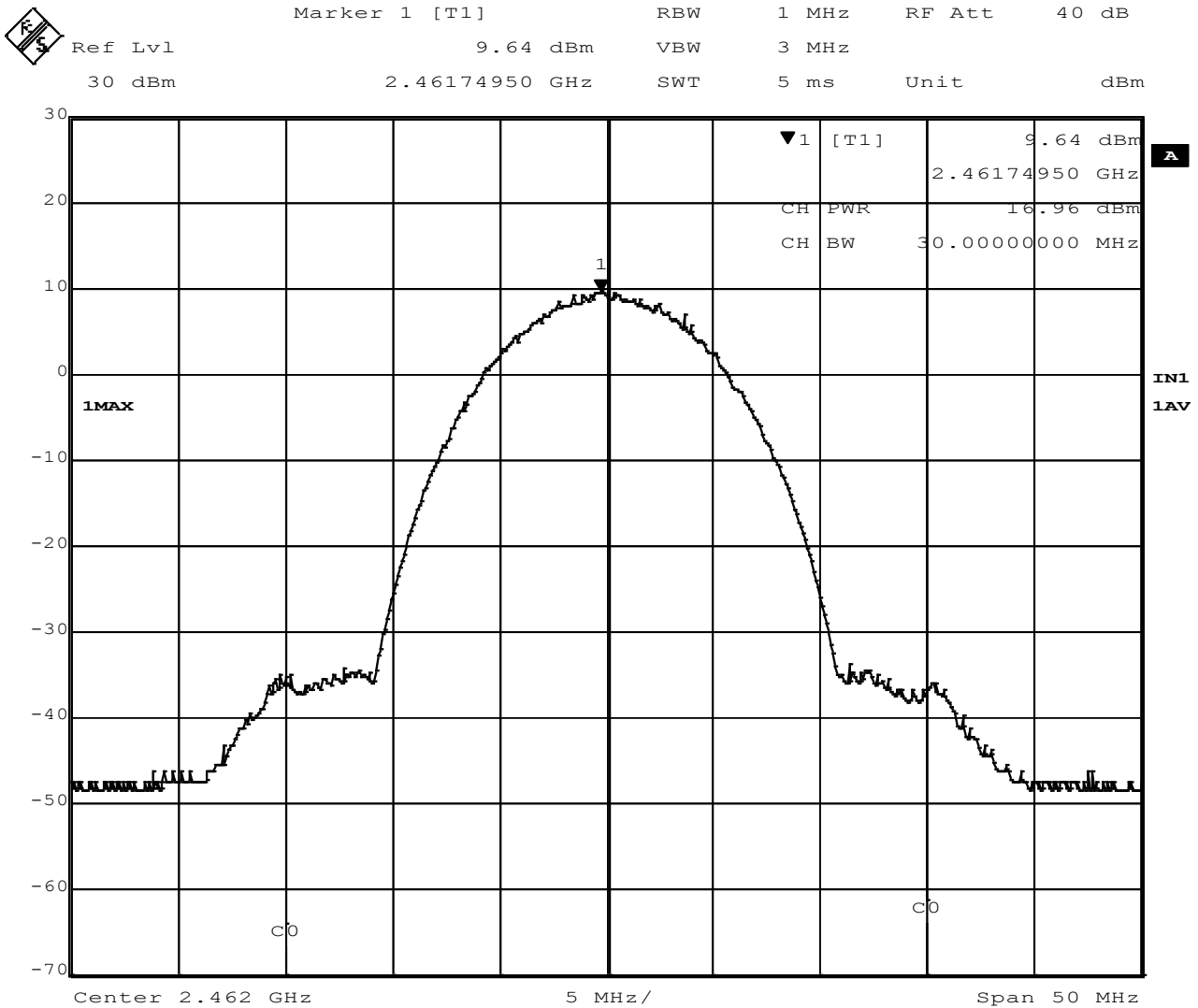


Figure 34 - Average Power Measurement, High Channel, 802.11b

Worst case was determined to be 1 Mbps for 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

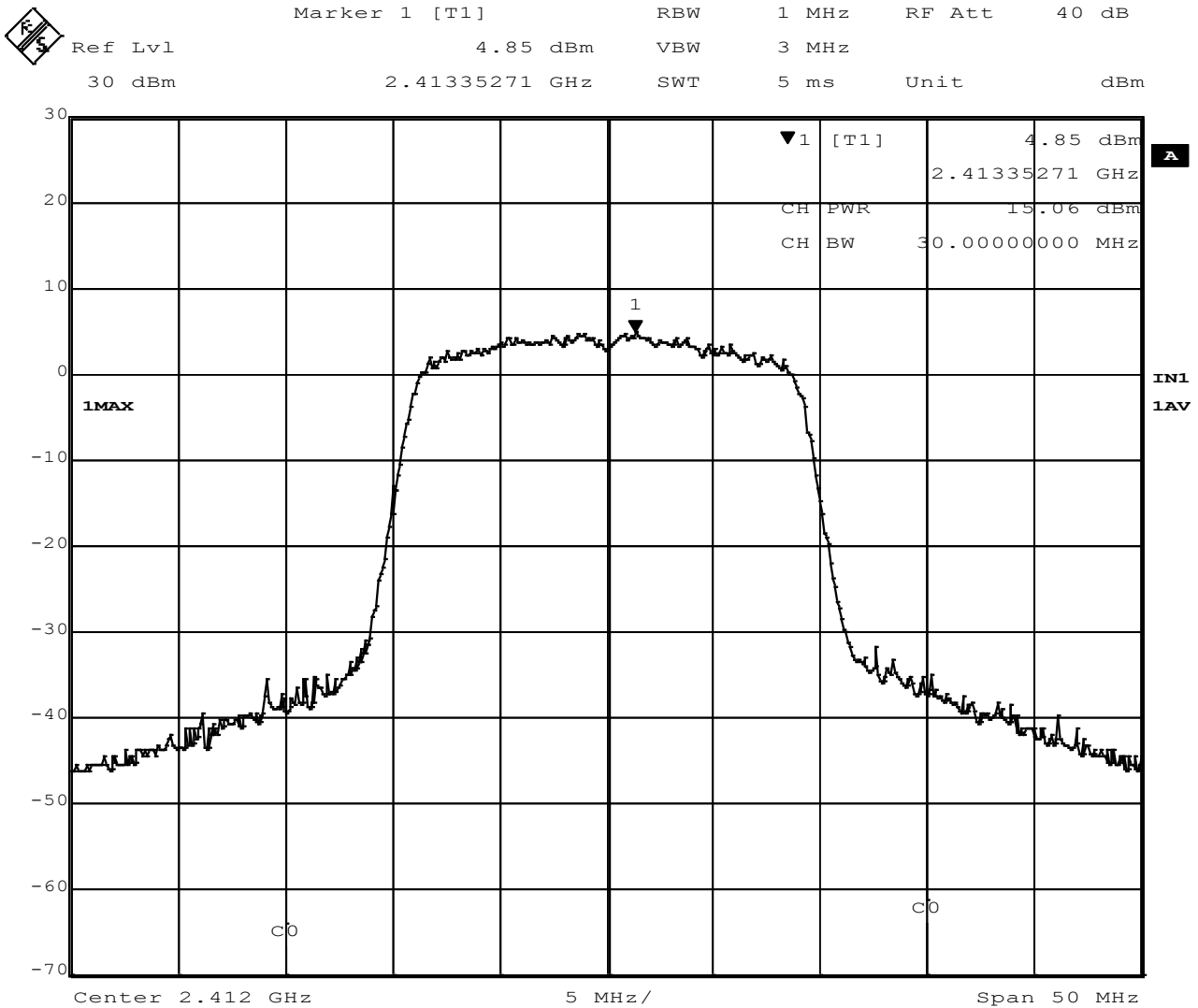


Figure 35 – Average Power Measurement, Low Channel, 802.11g

Worst case was determined to be 65 Mbps for 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

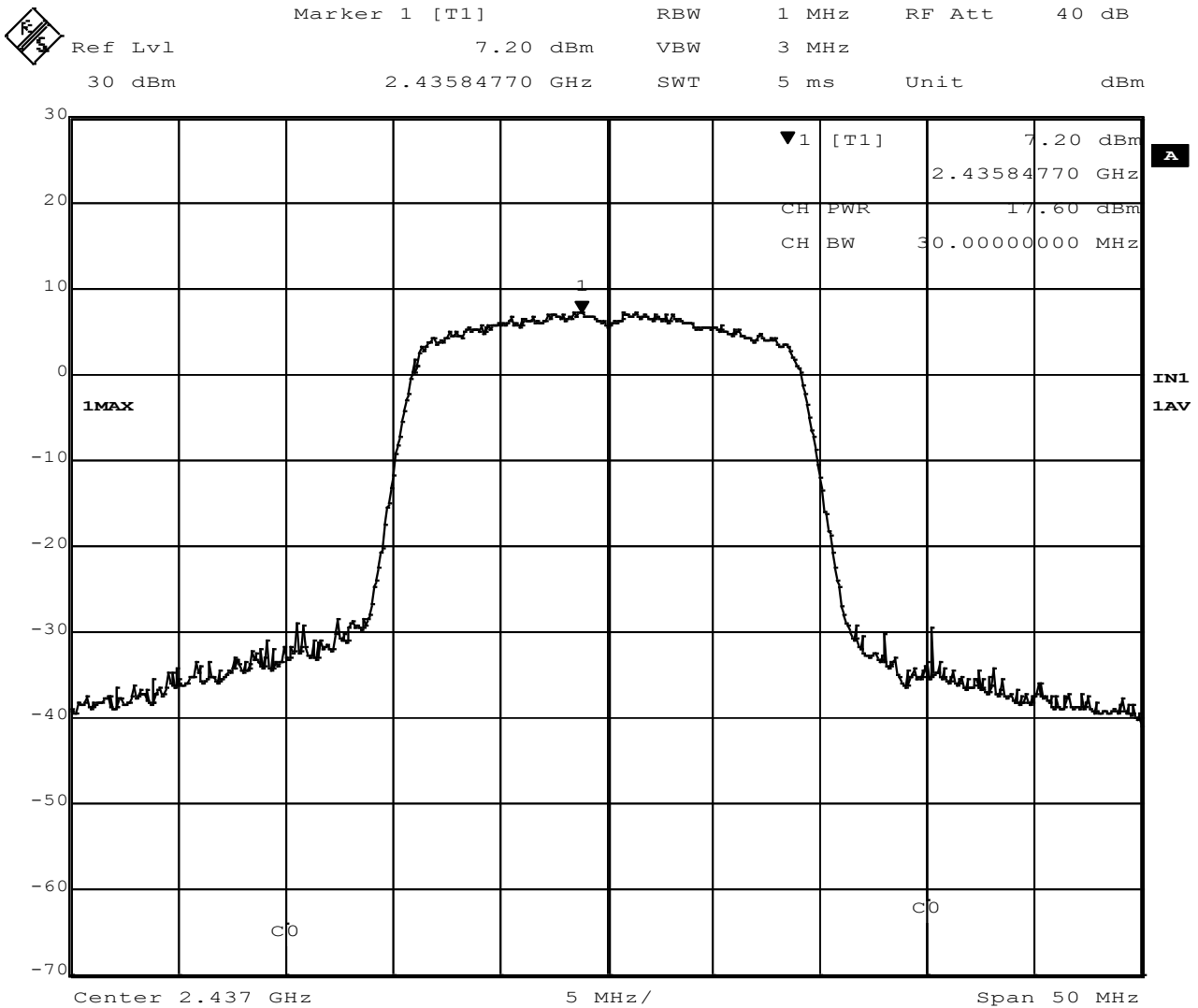


Figure 36 - Average Power Measurement, Mid Channel, 802.1g

Worst case was determined to be 65 Mbps for 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

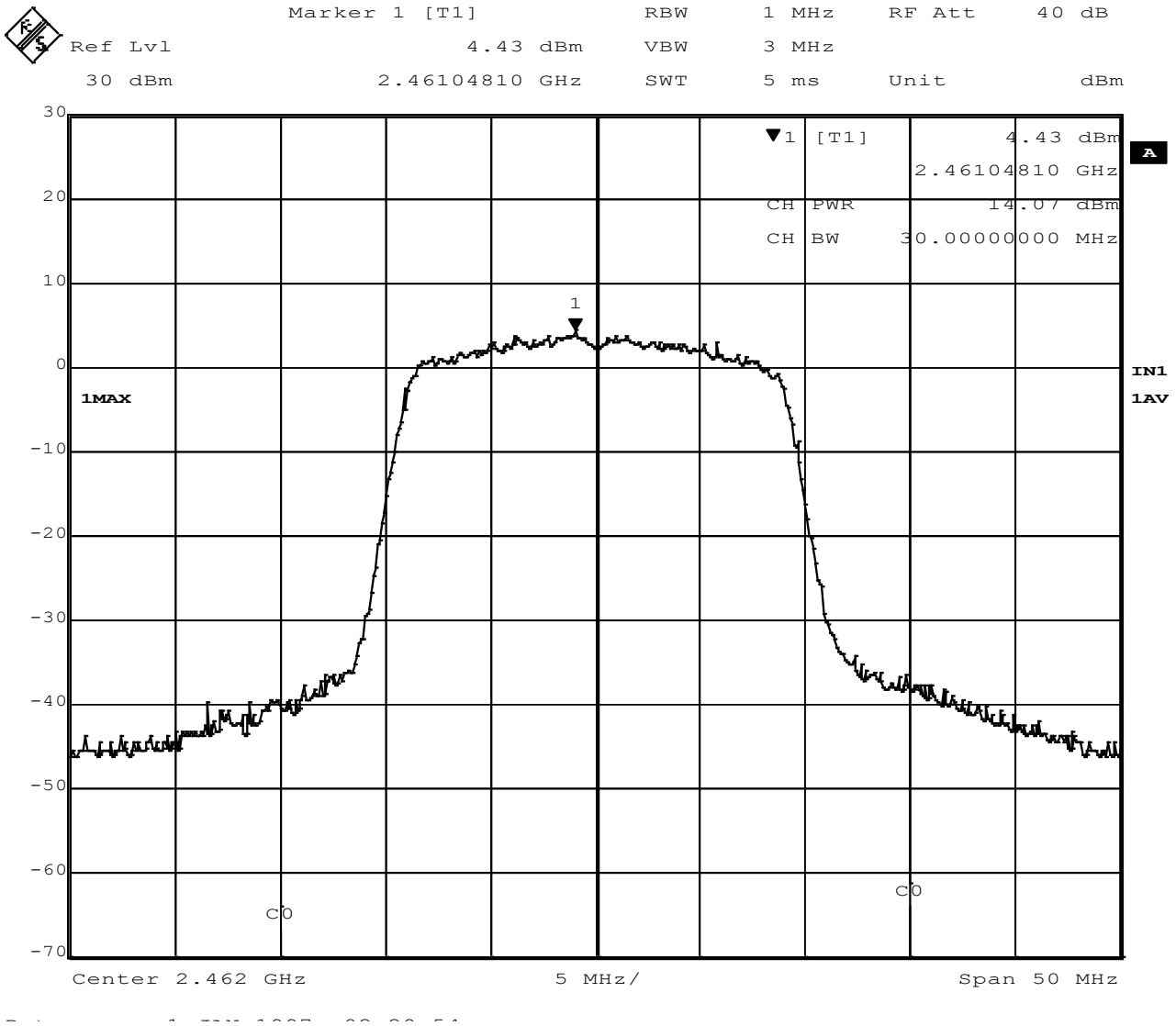


Figure 37 - Average Power Measurement, High Channel, 802.11g

Worst case was determined to be 65 Mbps for 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

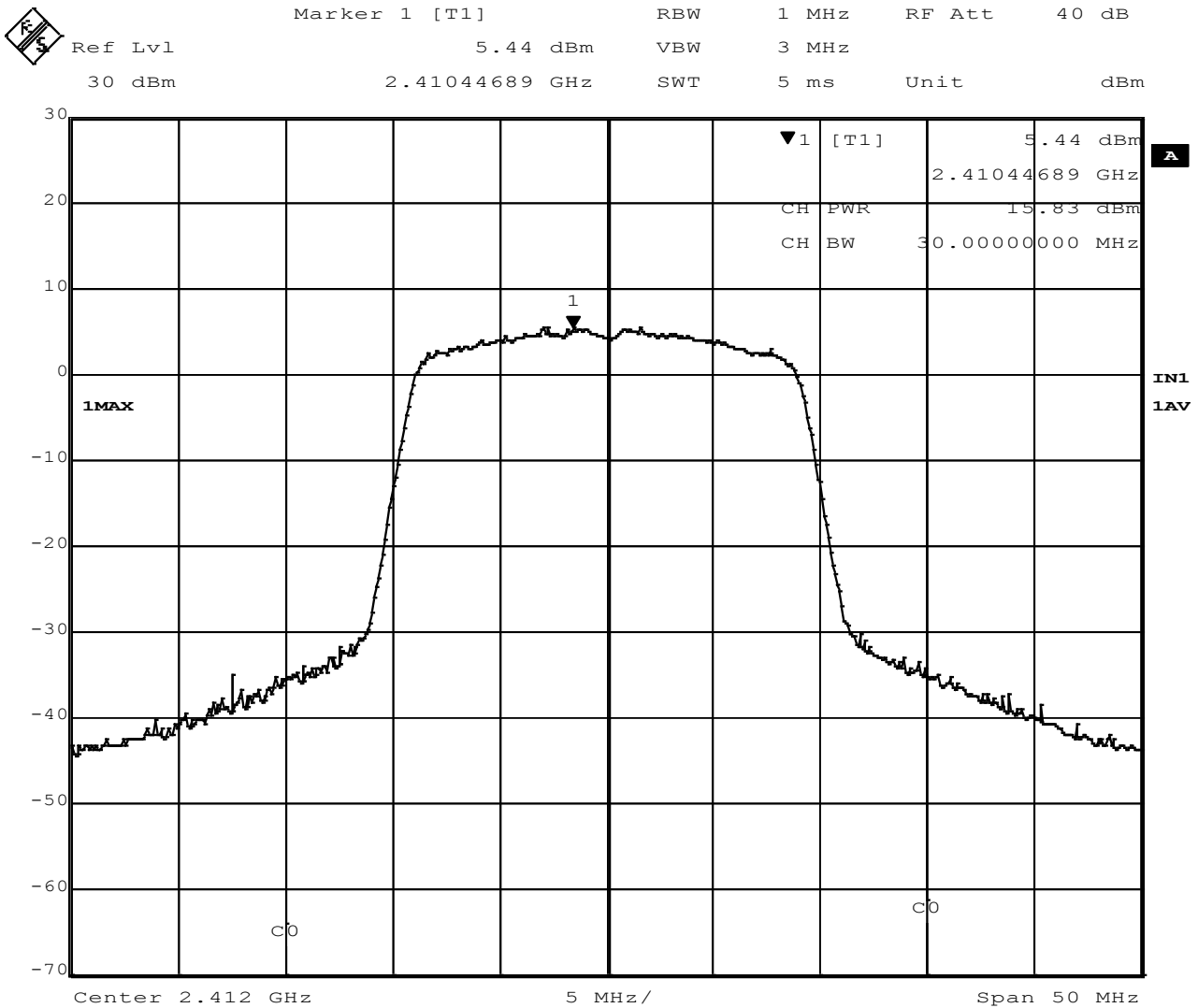


Figure 38 – Average Power Measurement, Low Channel, 802.11n

Worst case was determined to be MSC7 for 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

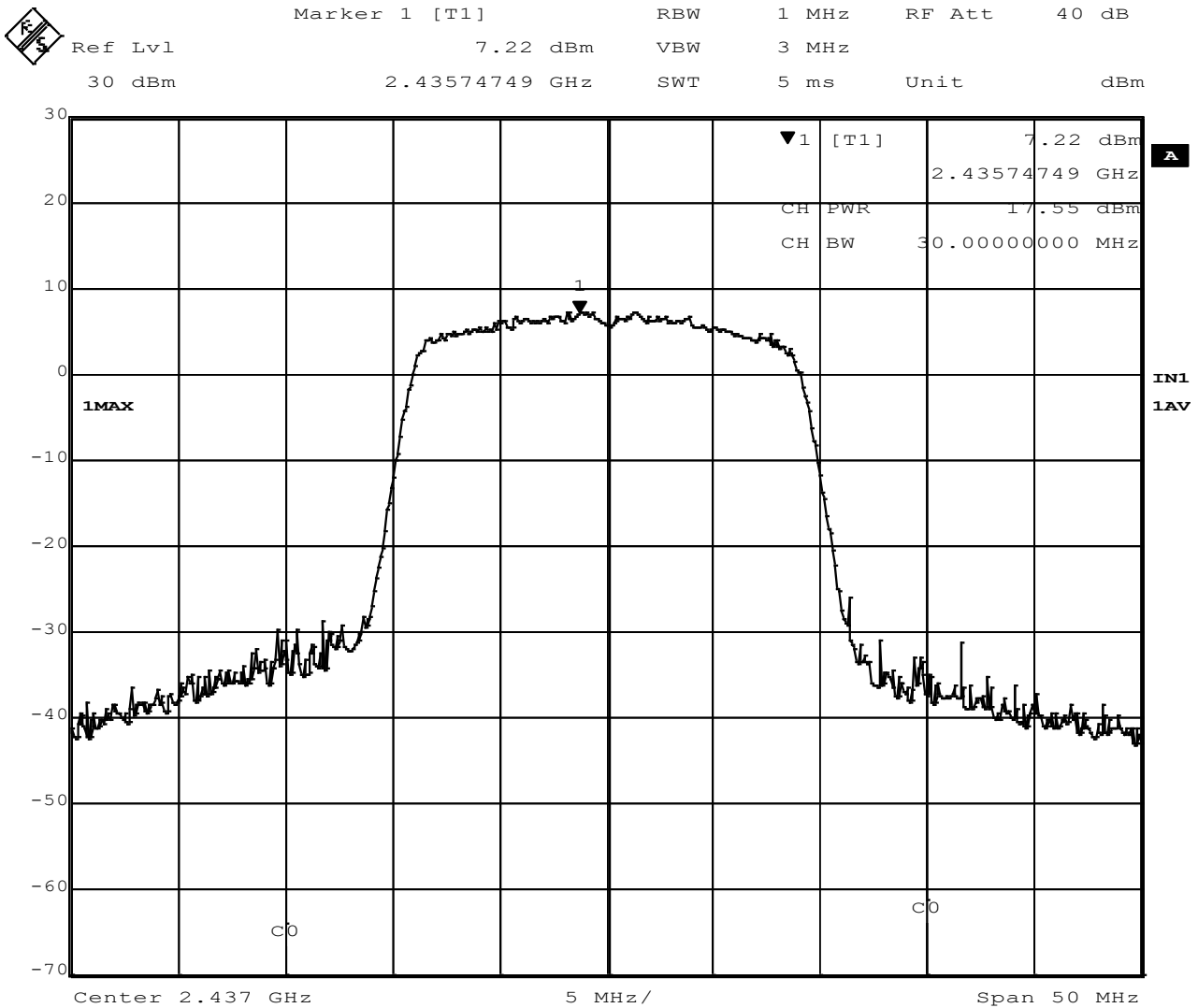


Figure 39 - Average Power Measurement, Mid Channel, 802.1n

Worst case was determined to be MSC7 for 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

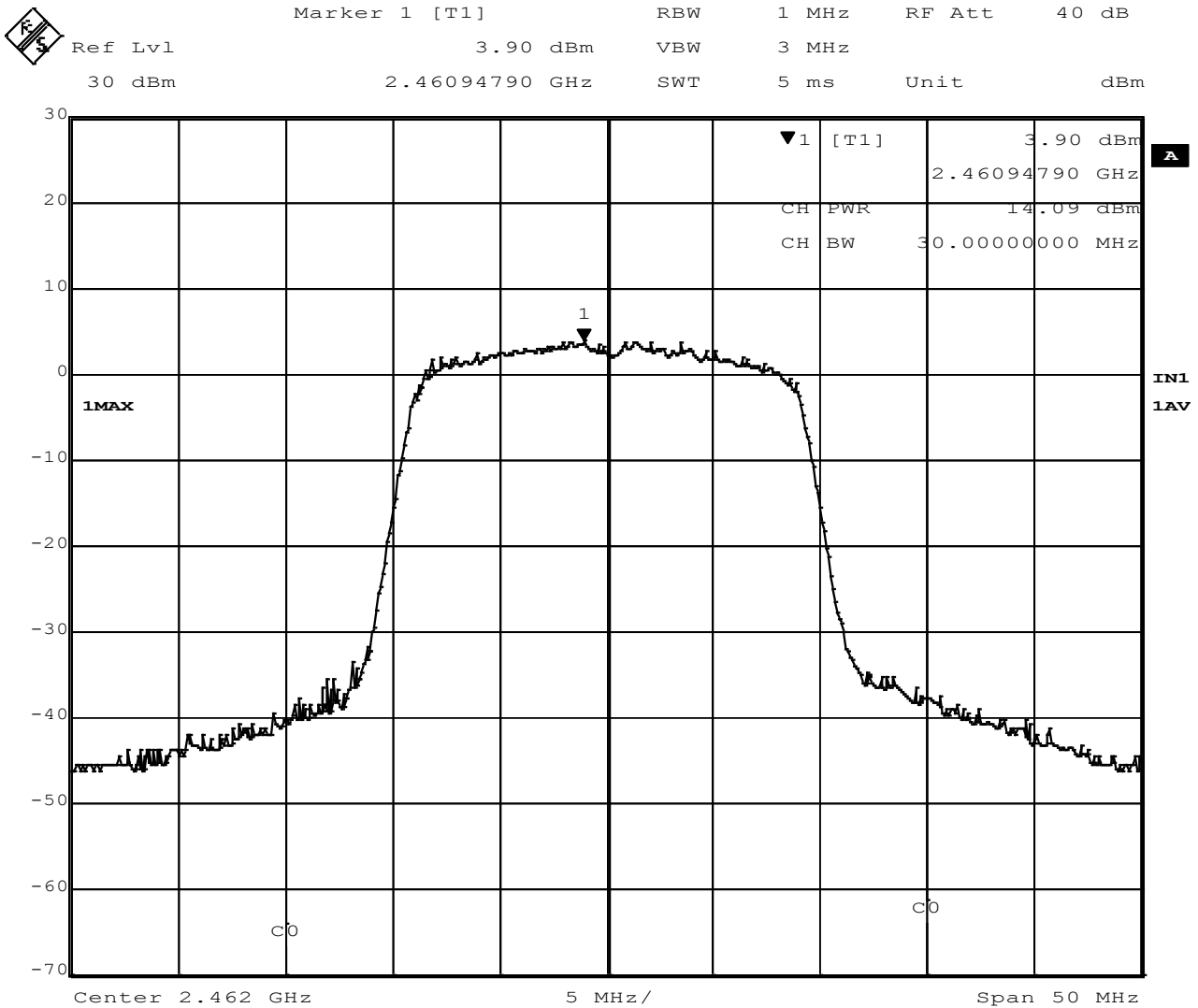


Figure 40 - Average Power Measurement, High Channel, 802.11n

Worst case was determined to be MSC7 for 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

4.4 BANDWIDTH

Test Method: ANSI C63.10,
1. Section(s) 11.8.1 “DTS Bandwidth, Option 1”

Limits of bandwidth measurements:
The 99% occupied bandwidth is displayed.

The 6dB bandwidth of the signal must be greater than 500 kHz.

Test procedures:

The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 kHz RBW and 300 kHz VBW.

The 99% occupied is defined as the bandwidth at which 99% of the signal power is found. This corresponds to 20dB down from the maximum power level. The maximum power was measured with the largest resolution bandwidth possible (10MHz) and this value was recorded. The signal was then captured with a 1 MHz resolution bandwidth and the frequencies where the measurements were 20dB below the maximum power were marked. The bandwidth between these frequencies was recorded as the 99% occupied bandwidth.

The 6 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 6dB.

For peak output power measurements, the EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable with 3 MHz RBW and 10 MHz VBW.

Deviations from test standard:
No deviation

Test setup:

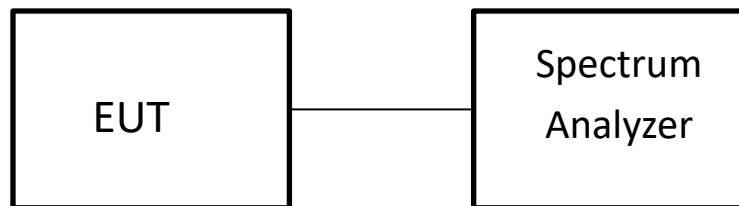


Figure 41 – Peak Output Power Measurements Test Setup

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

EUT operating conditions:

The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

Test results:

99% Occupied Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	WIFI Type	99% Occupied BW (MHz)
Low	2412	802.11b	13.73
Middle	2437	802.11b	13.73
High	2462	802.11b	13.73
Low	2412	802.11g	17.59
Middle	2437	802.11g	17.59
High	2462	802.11g	17.64
Low	2412	802.11n	17.59
Middle	2437	802.11n	17.64
High	2462	802.11n	17.58

6dB Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	WIFI Type	6 dB BW (MHz)
Low	2412	802.11b	8.7
Middle	2437	802.11b	9.4
High	2462	802.11b	8.7
Low	2412	802.11g	16.6
Middle	2437	802.11g	16.1
High	2462	802.11g	16.5
Low	2412	802.11n	17.7
Middle	2437	802.11n	17.5
High	2462	802.11n	17.6

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

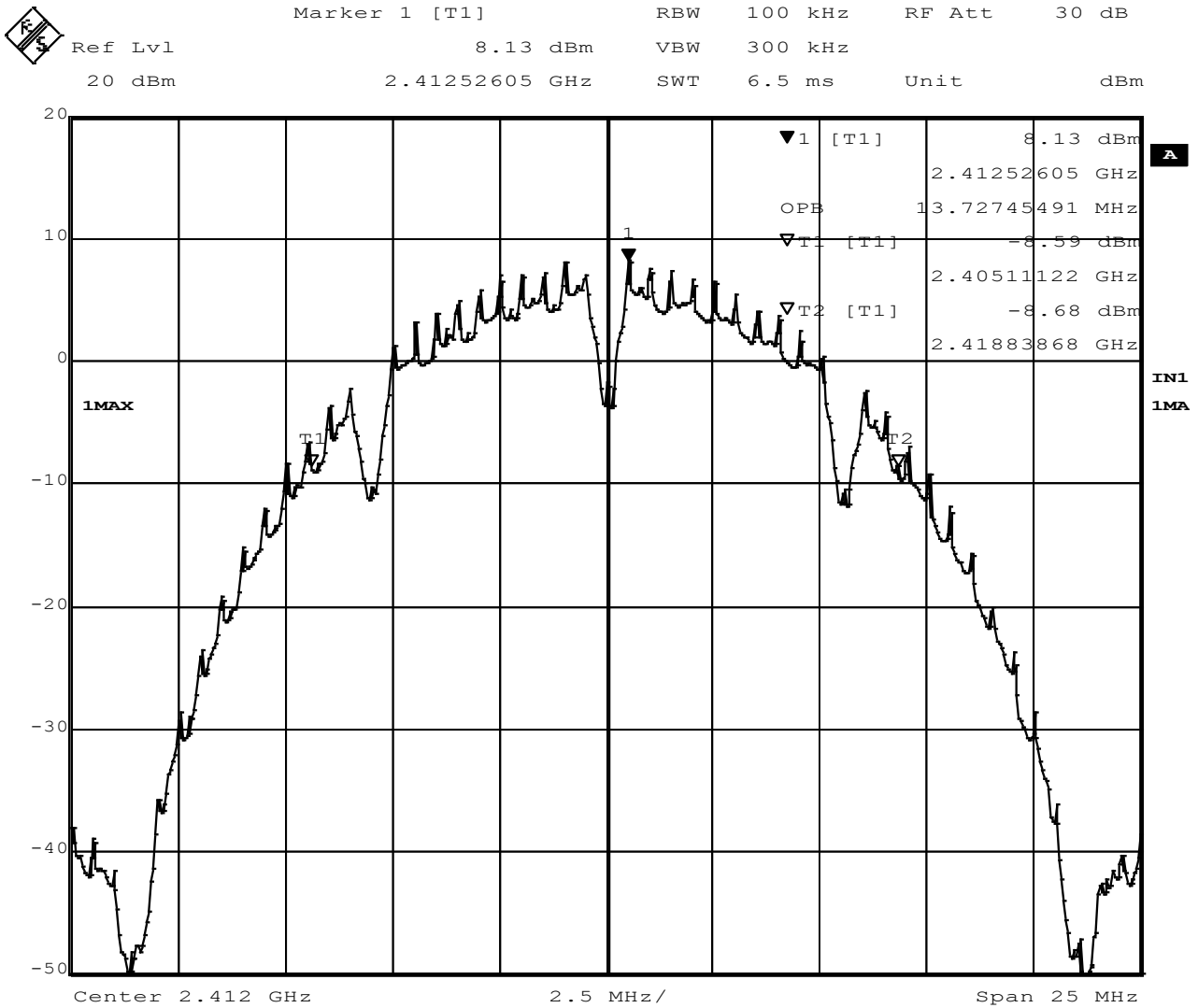


Figure 42 - 99% Occupied Bandwidth, Low Channel, 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

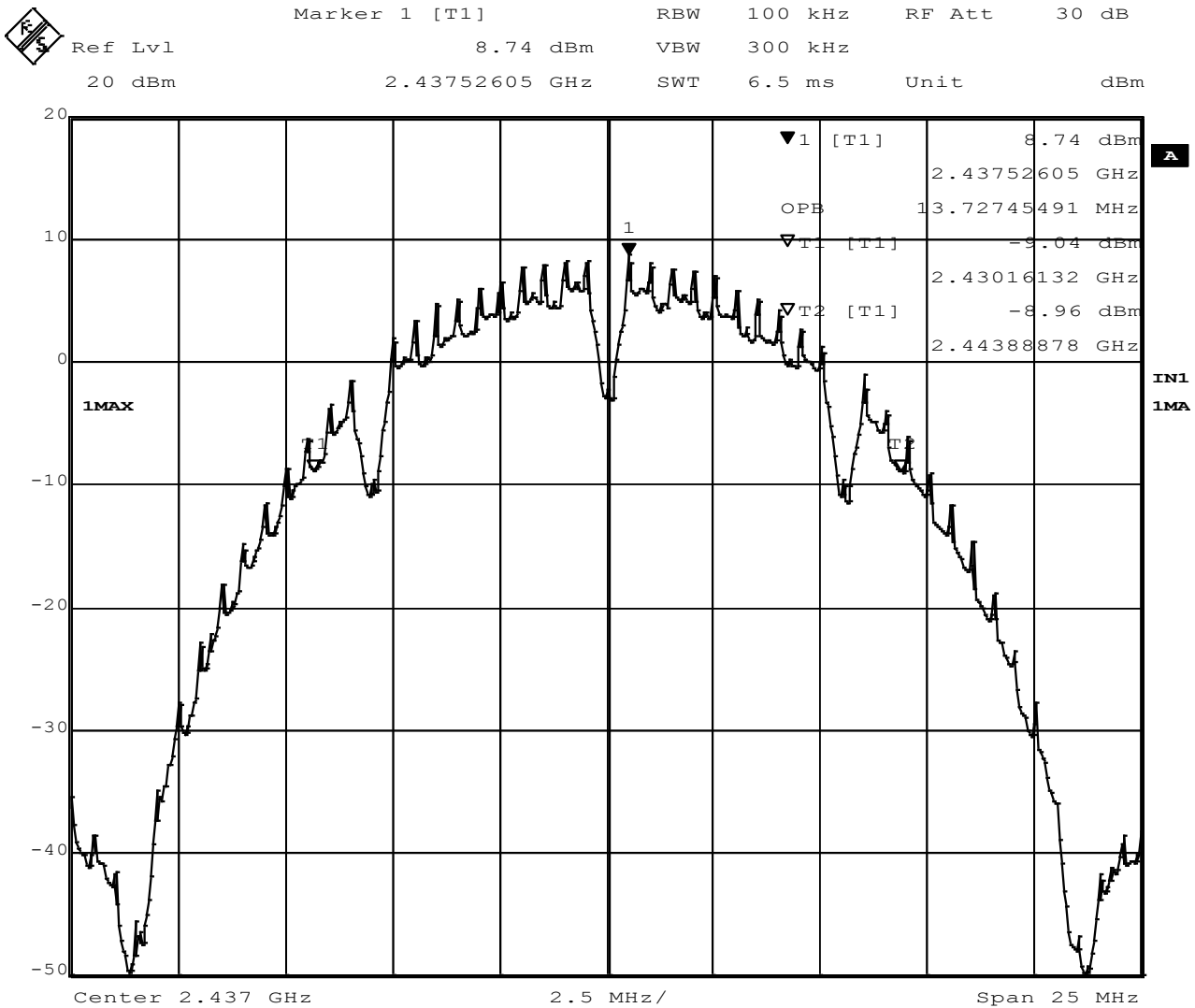


Figure 43 - 99% Occupied Bandwidth, Mid Channel, 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

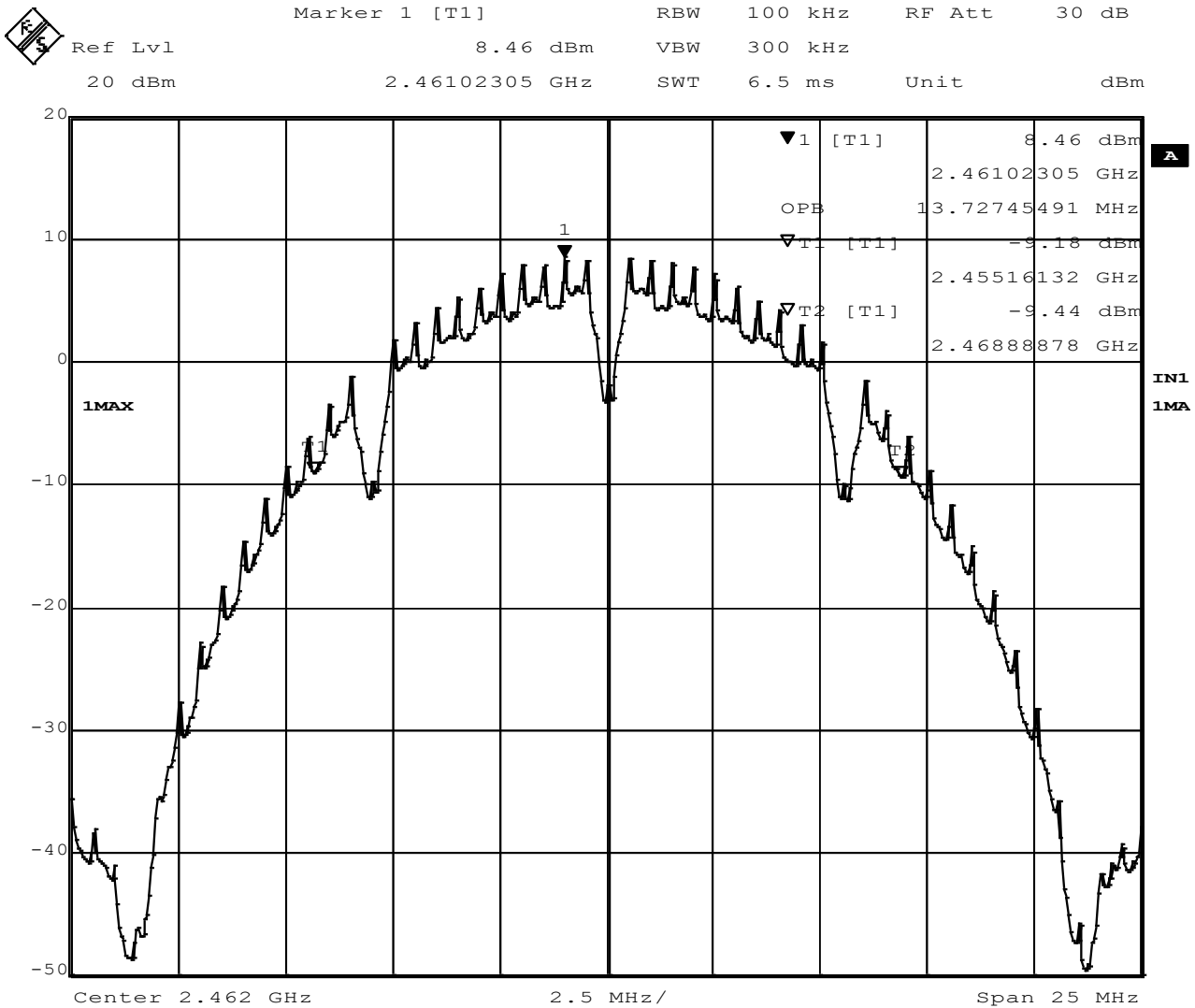


Figure 44 - 99% Occupied Bandwidth, High Channel, 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

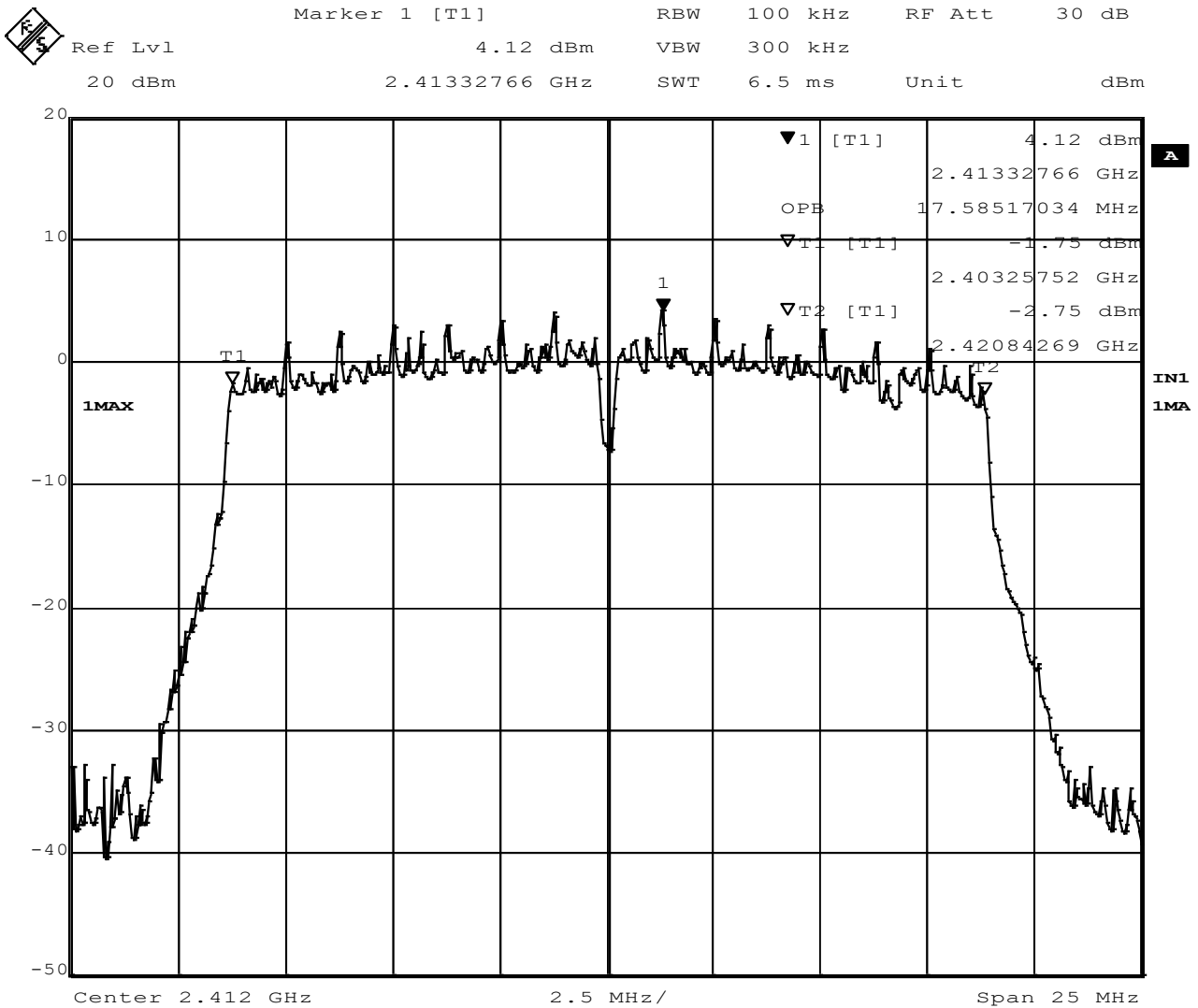


Figure 45 - 99% Occupied Bandwidth, Low Channel, 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

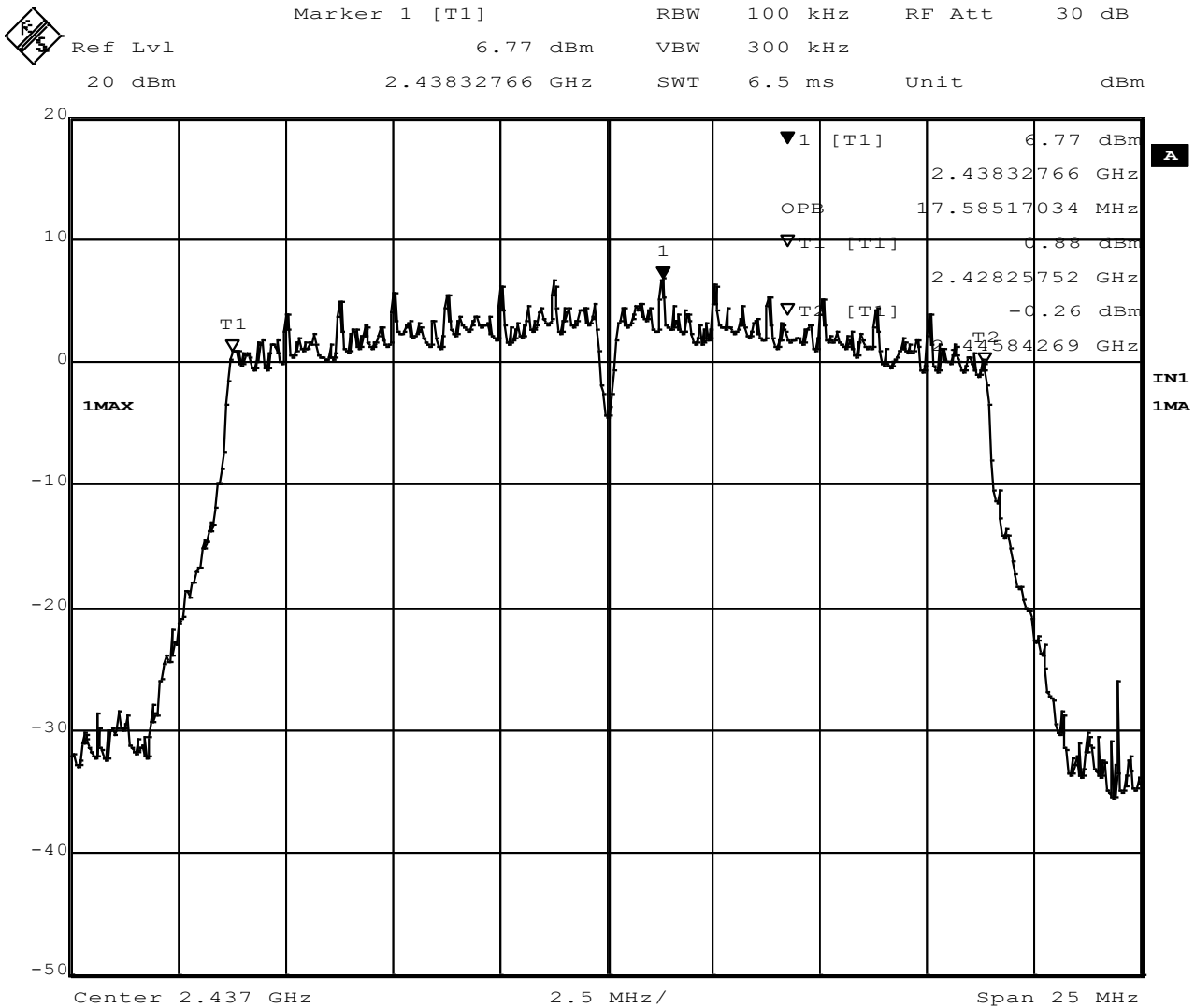


Figure 46 - 99% Occupied Bandwidth, Mid Channel, 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

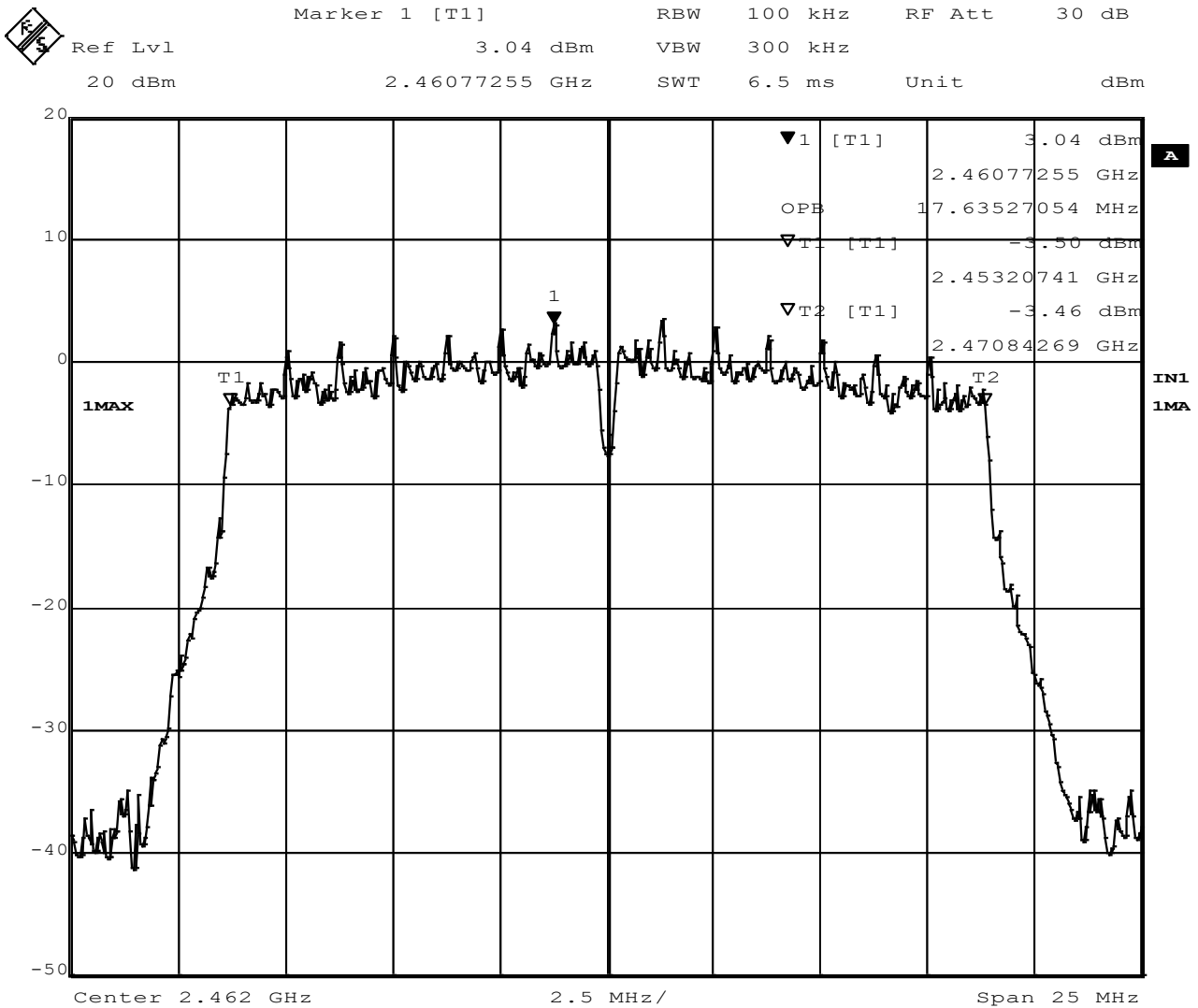


Figure 47 - 99% Occupied Bandwidth, High Channel, 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

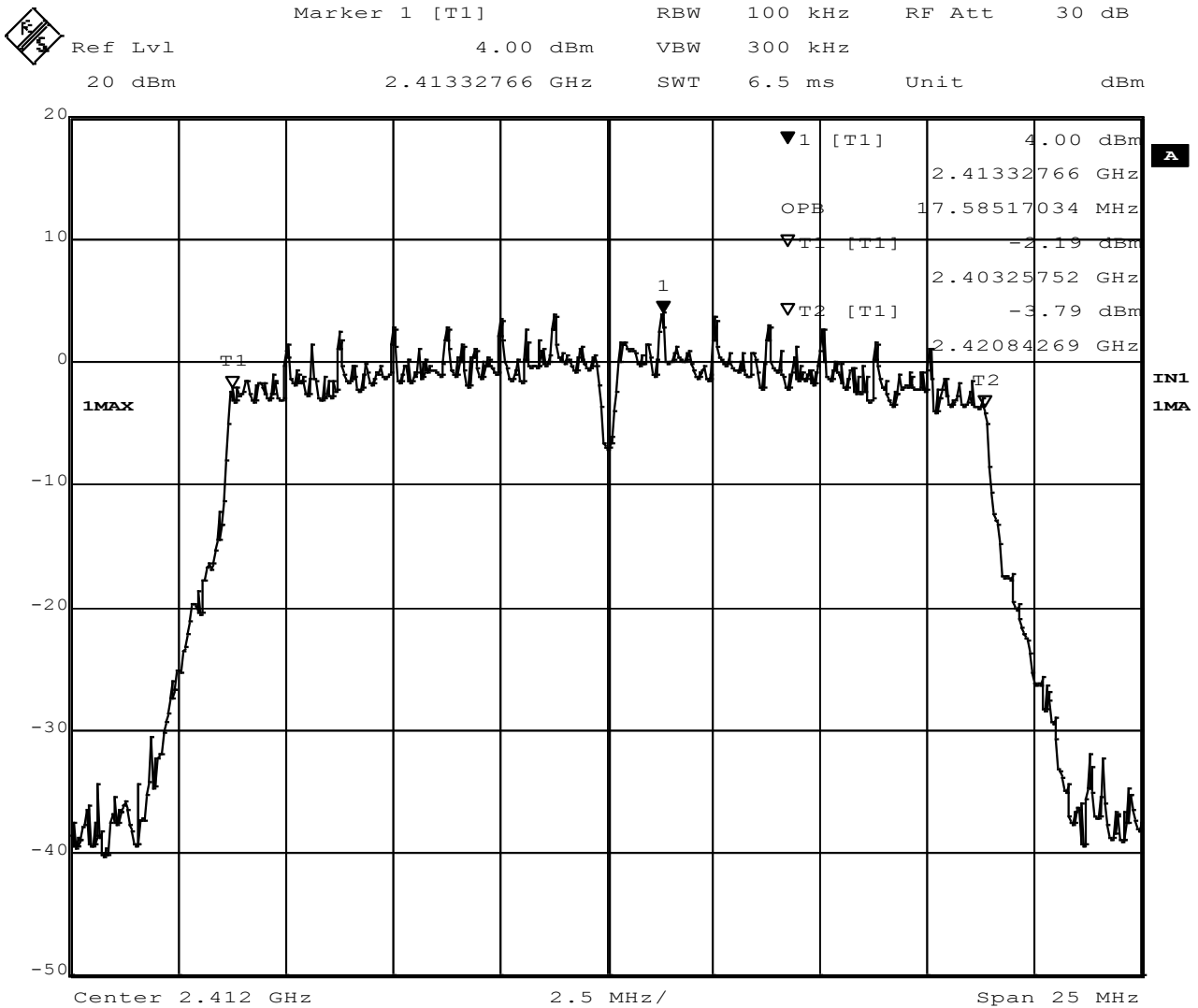


Figure 48 - 99% Occupied Bandwidth, Low Channel, 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

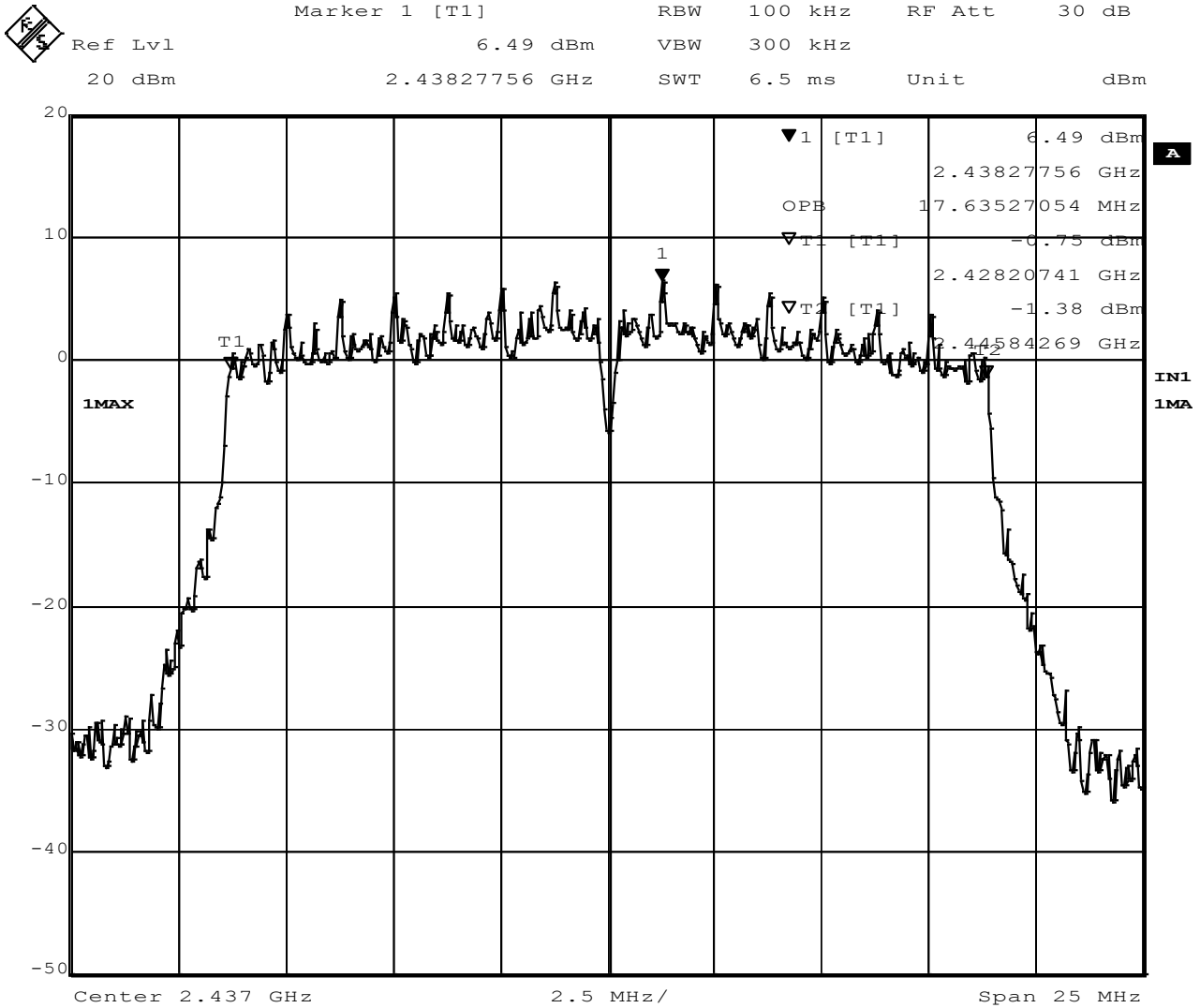
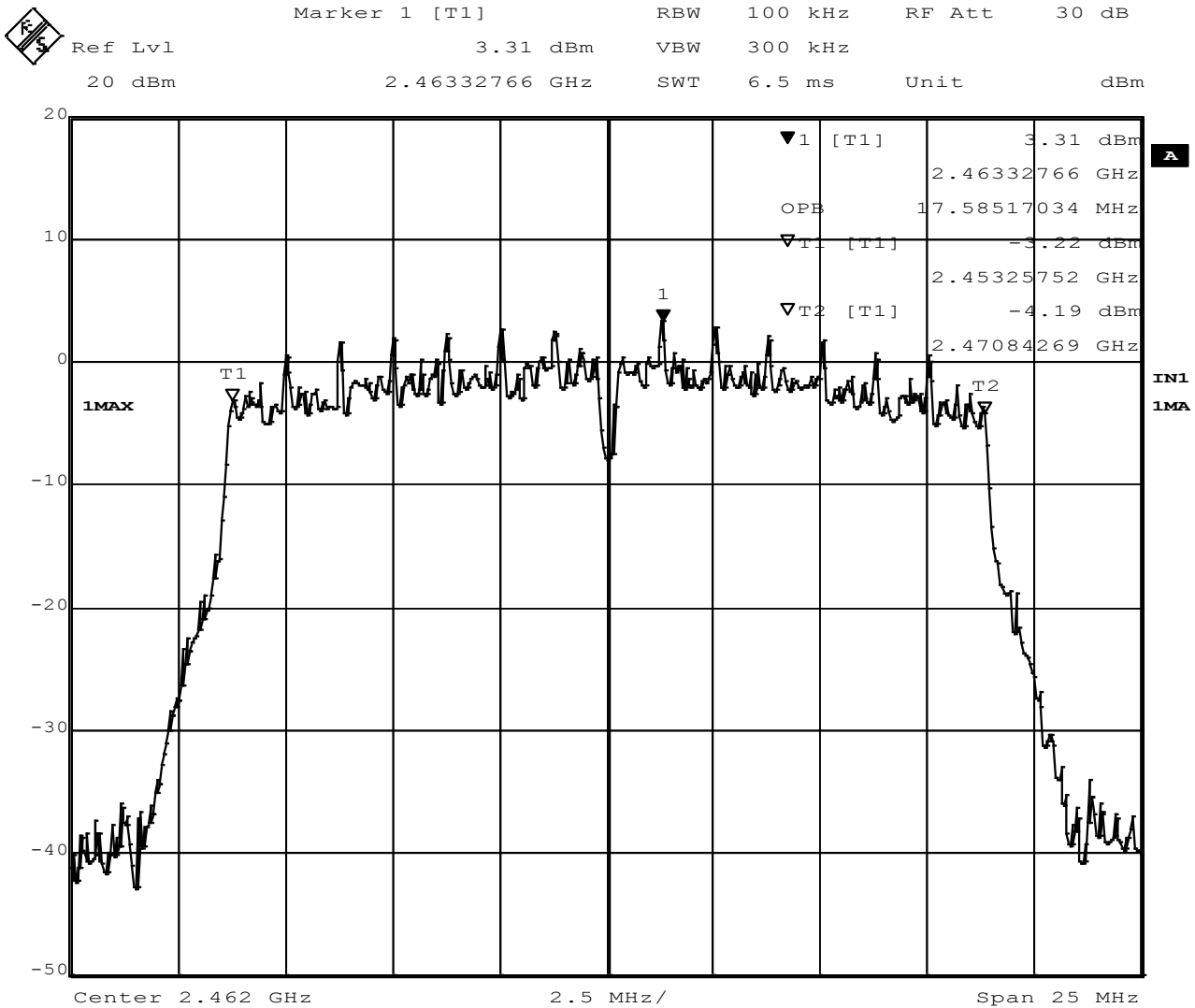


Figure 49 - 99% Occupied Bandwidth, Mid Channel, 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		



Date: 1 JAN 1987 00:40:36
 Figure 50 - 99% Occupied Bandwidth, High Channel, 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

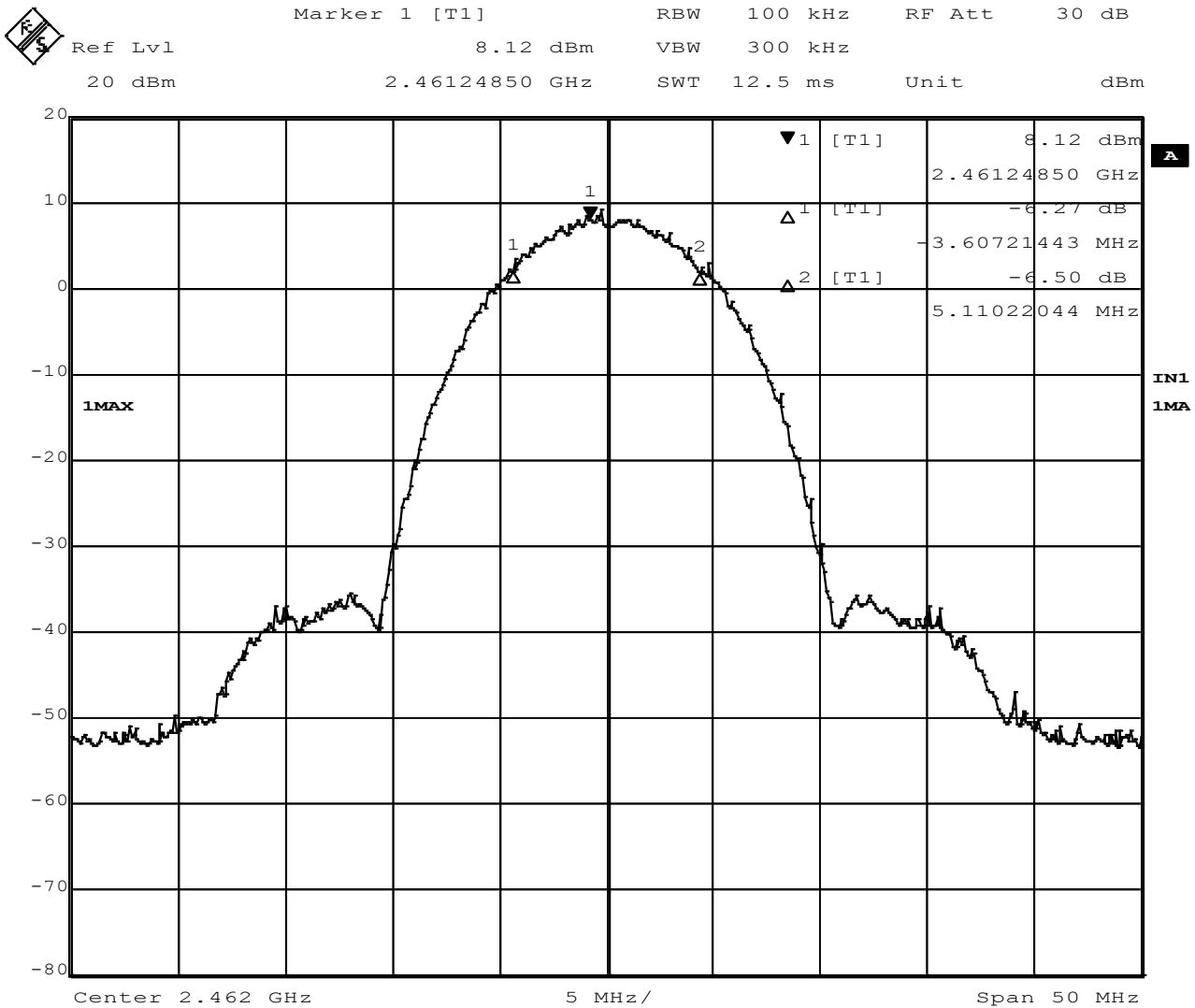


Figure 51 - 6dB Bandwidth, Low Channel, 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

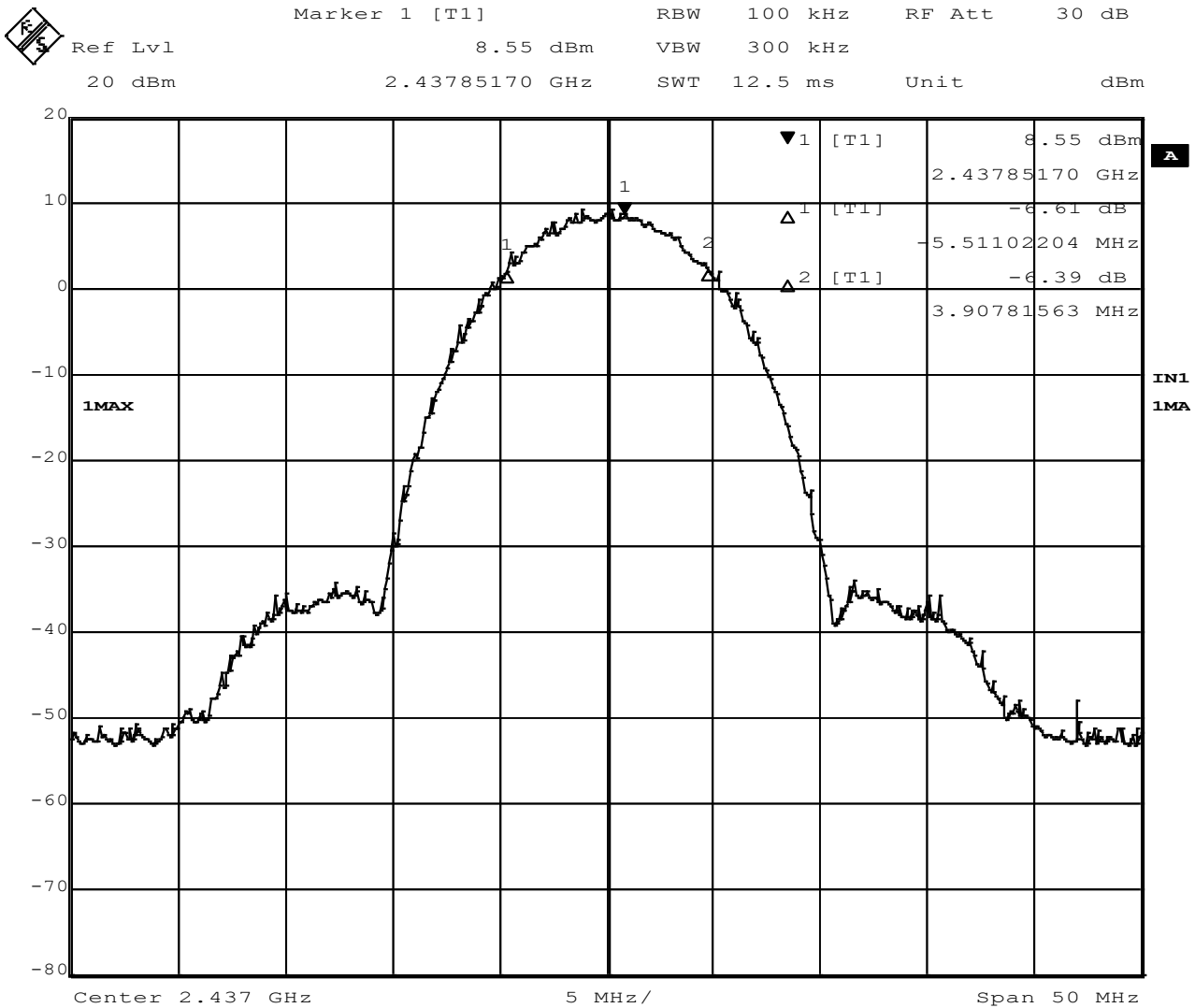


Figure 52 - 6dB Bandwidth, Mid Channel, 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

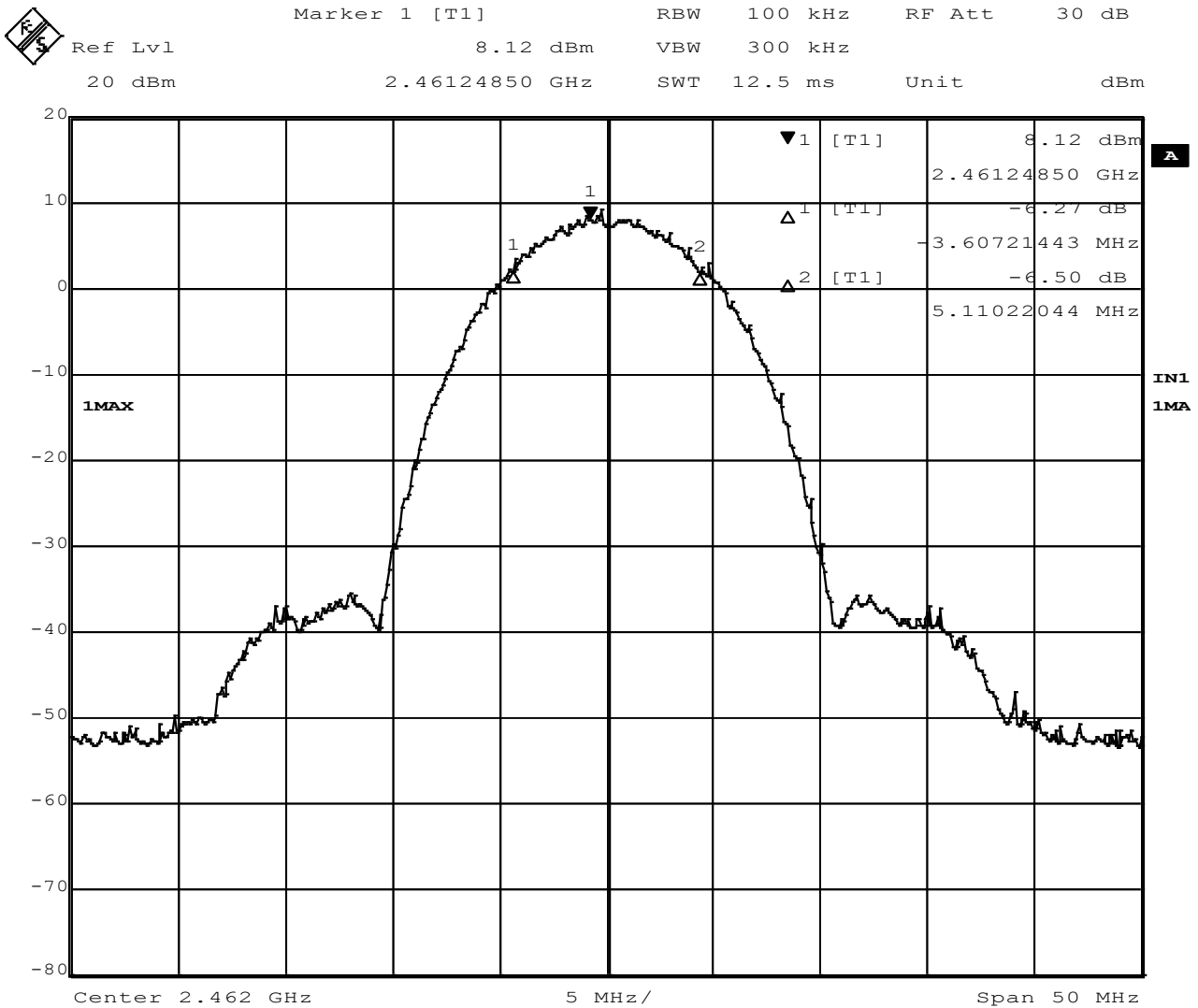


Figure 53 - 6dB Bandwidth, High Channel, 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

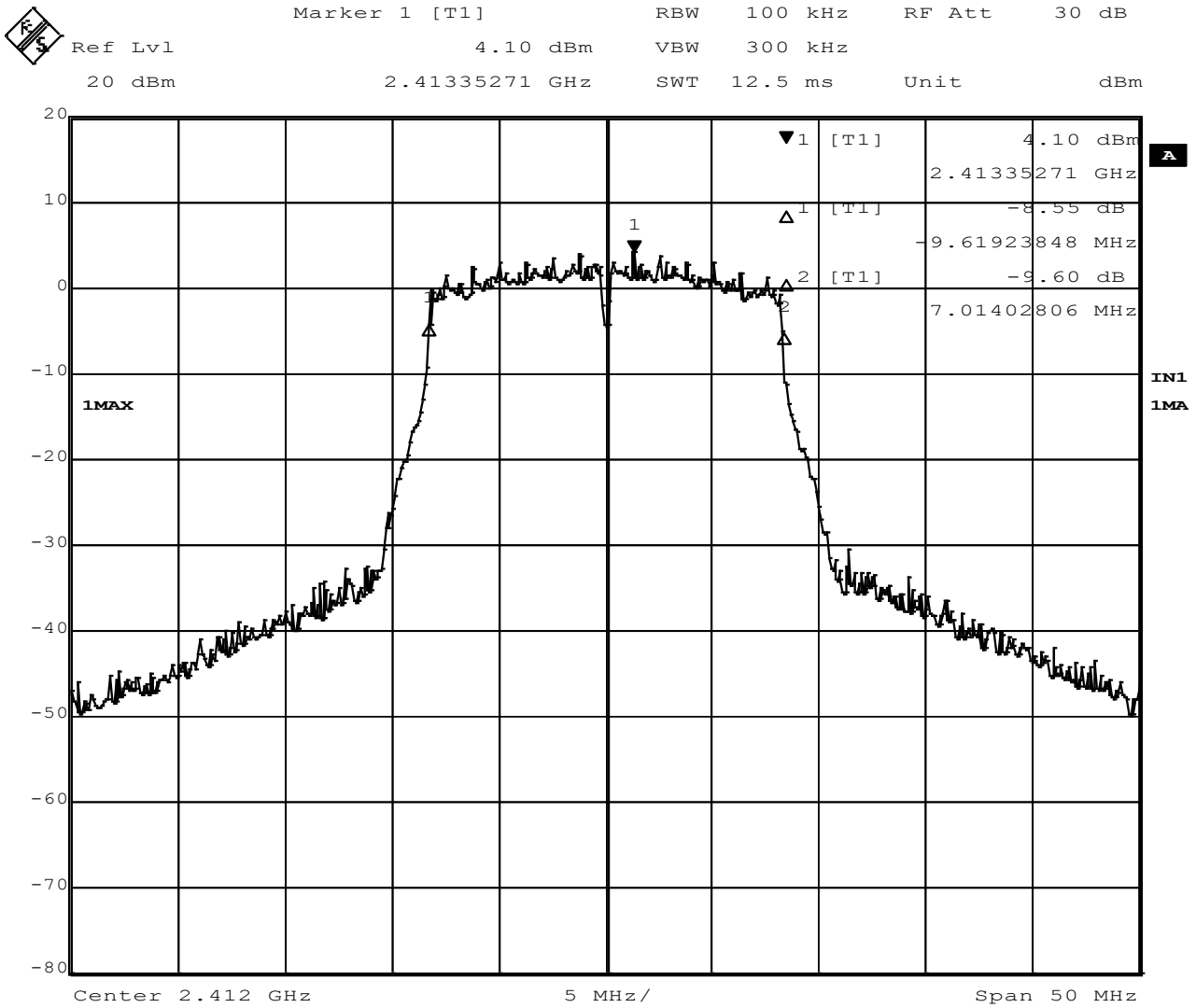


Figure 54 - 6dB Bandwidth, Low Channel, 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

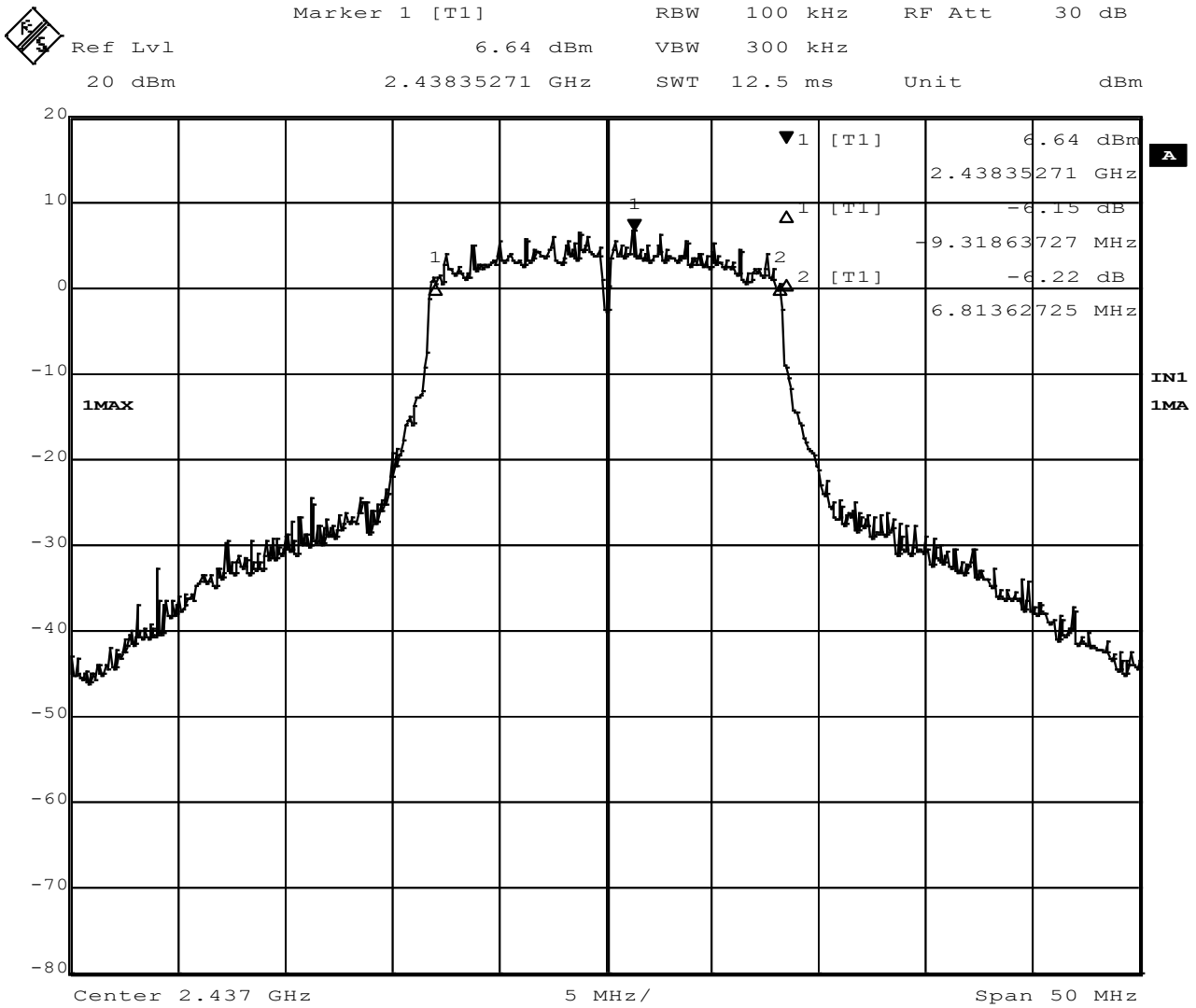


Figure 55 - 6dB Bandwidth, Mid Channel, 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

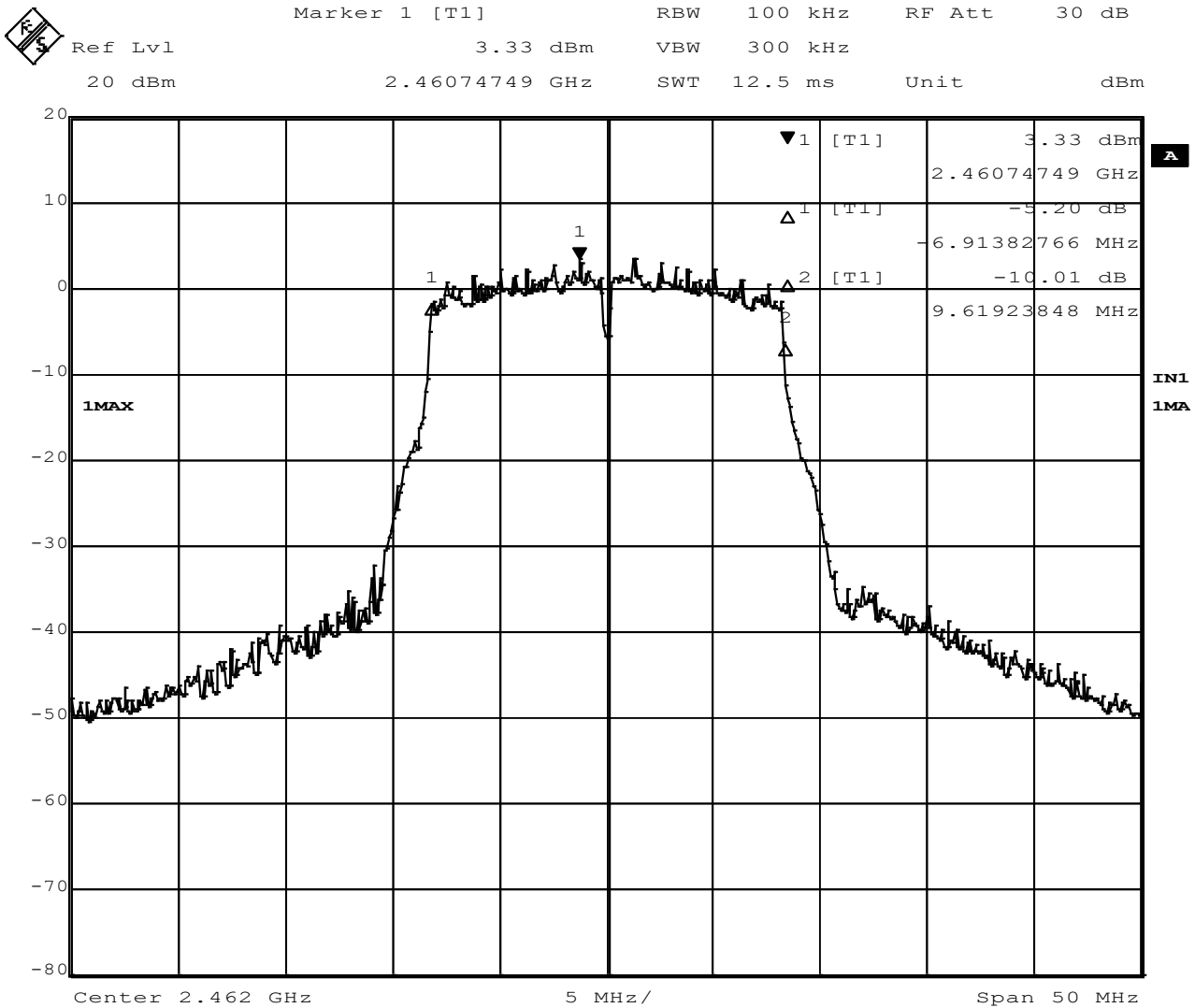


Figure 56 - 6dB Bandwidth, High Channel, 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

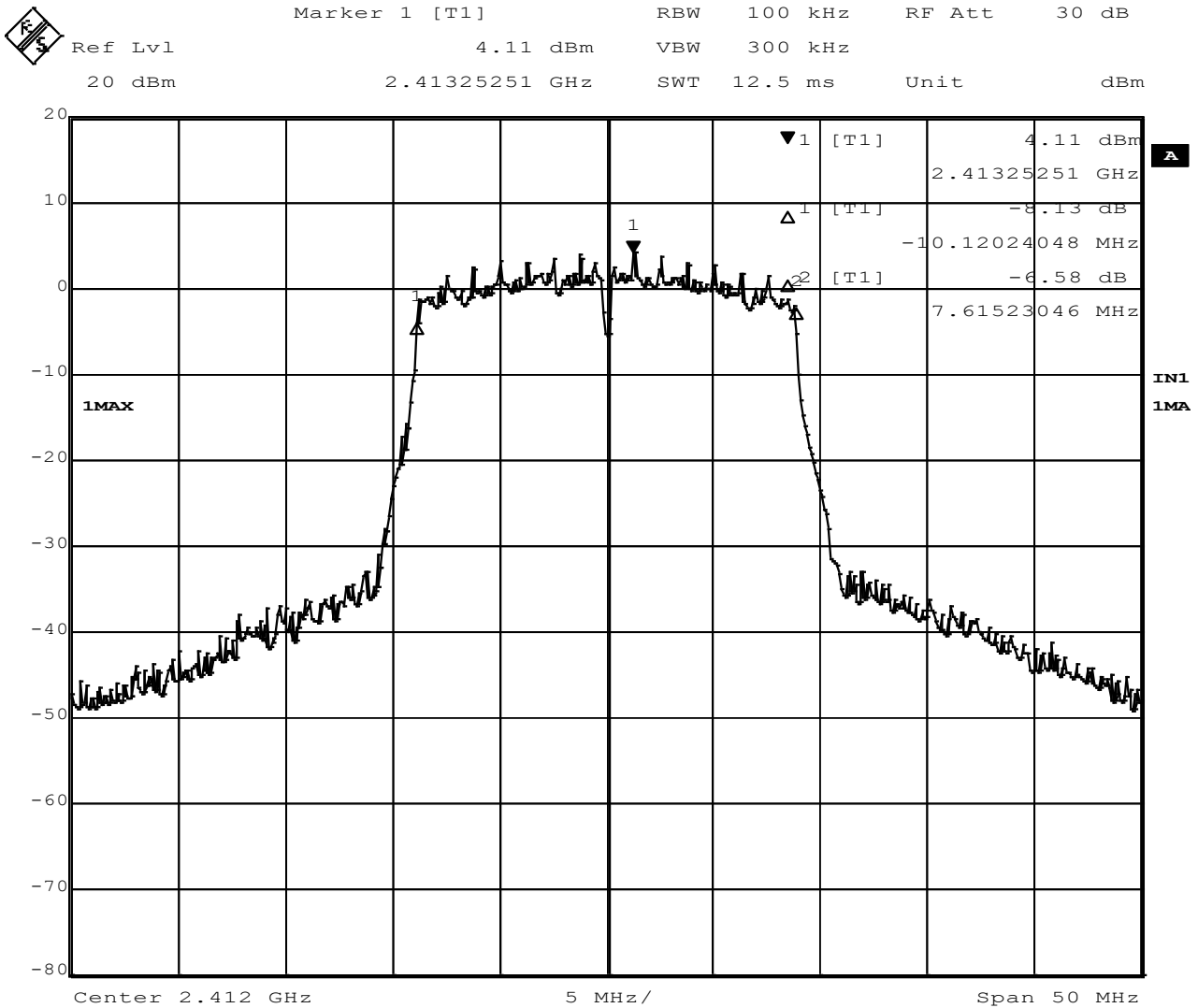


Figure 57 - 6dB Bandwidth, Low Channel, 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

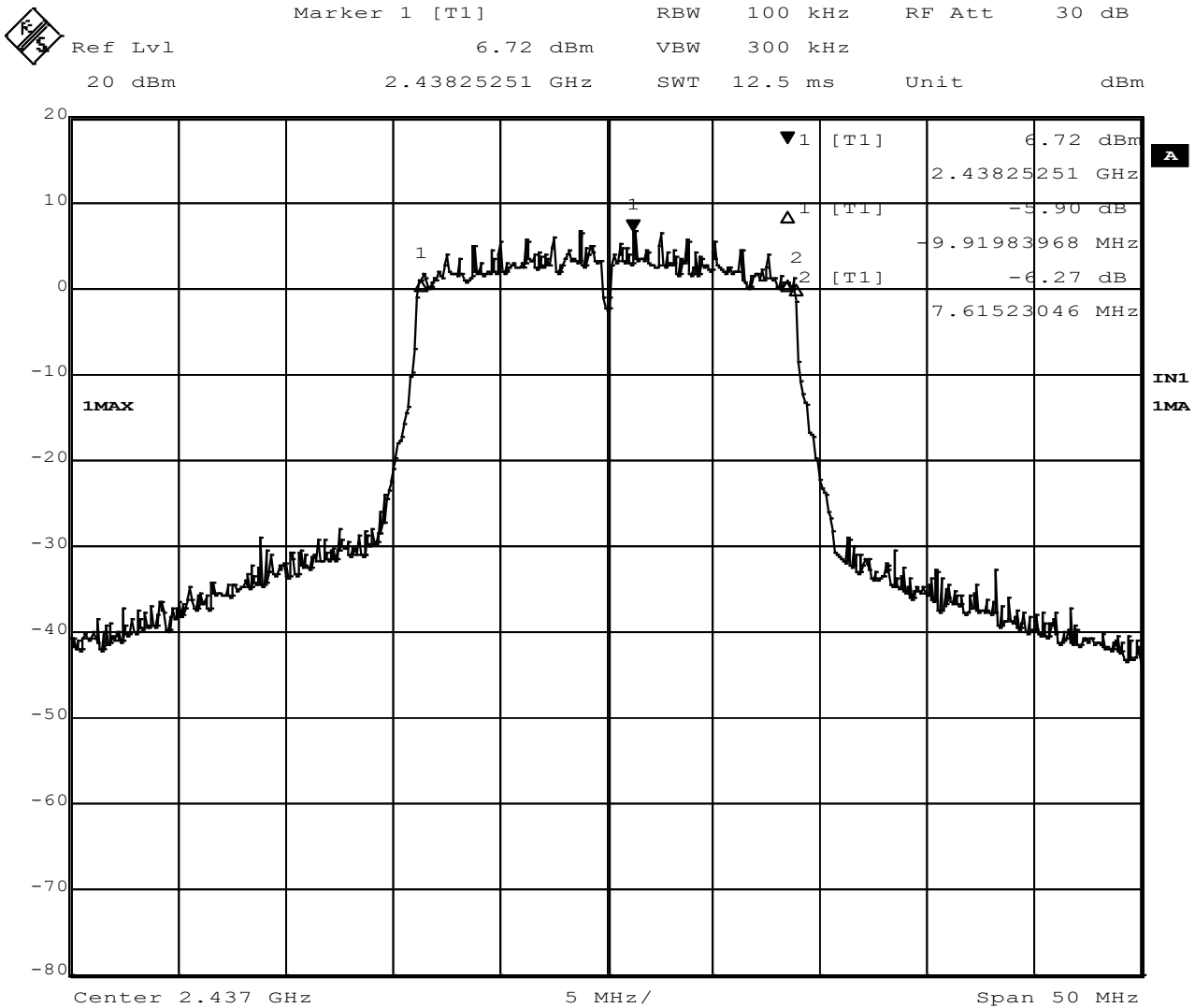


Figure 58 - 6dB Bandwidth, Mid Channel, 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

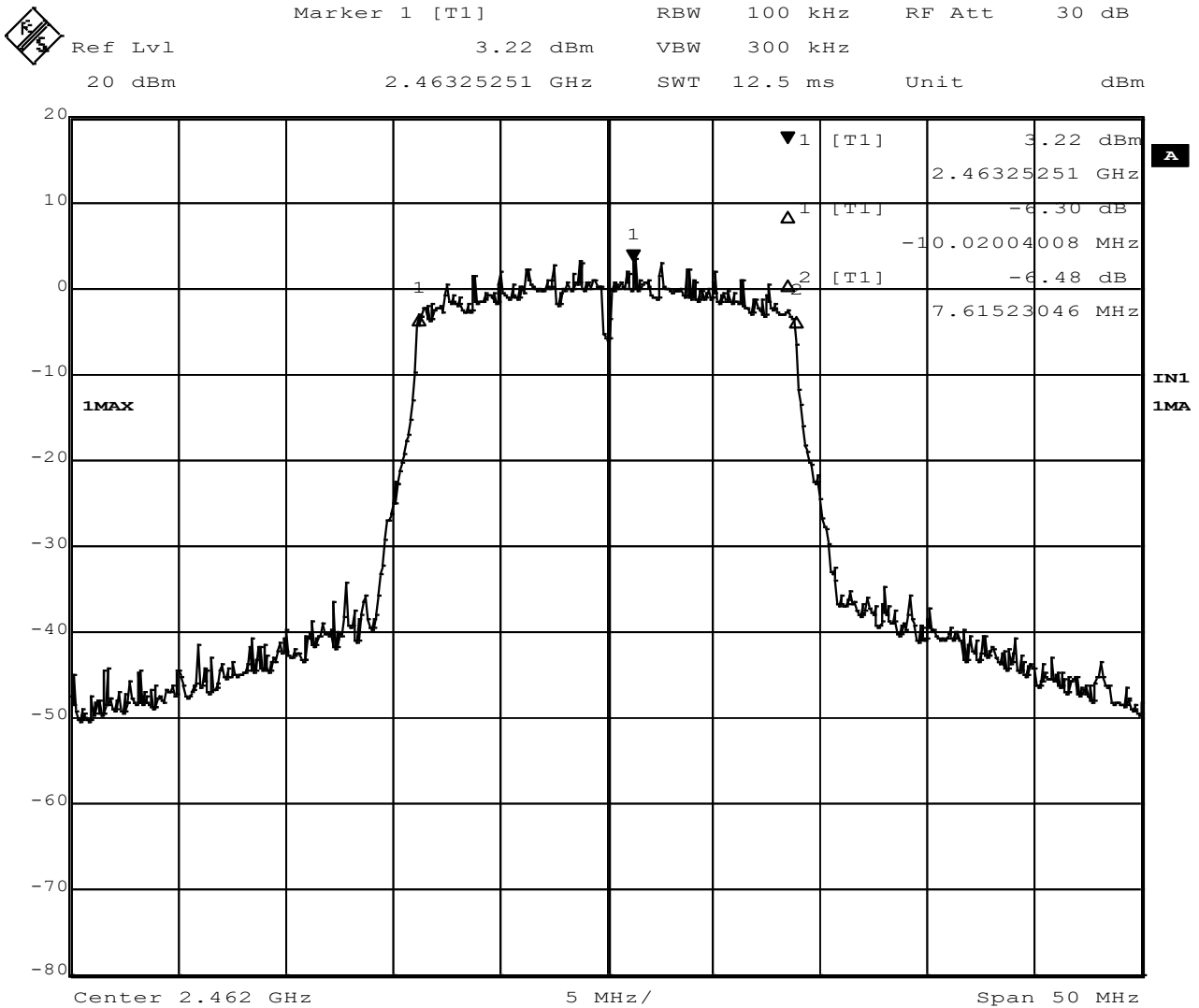


Figure 59 - 6dB Bandwidth, High Channel, 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

4.5 BANDEDGES

Test Method: ANSI C63.10:

1. Section 6.10.5 (used for restricted bands)
2. Section 11.13.2 "Marker-delta method" (for unrestricted bands)
3. Section 11.11, "Measurement in unrestricted frequency bands"

Limits of bandedge measurements:

For emissions outside of the allowed band of operation (2400.0MHz – 2480.0MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

Test procedures:

The EUT was tested in the same method as described in section 4.4 - *Bandwidth*. The resolution bandwidth was set to 100kHz and video bandwidth to 300 kHz the EMI receiver was used to scan from the bandedge to the fundamental frequency with a quasi-peak detector. The highest emissions level beyond the bandedge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209.

Deviations from test standard:

No deviation.

Test setup:

See Section 4.3

EUT operating conditions:

The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

Test results:

Highest Out of Band Emissions, 802.11b

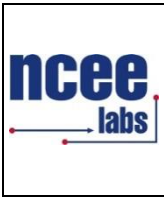
CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level dBm	Fundamental Level (dBm)	Delta	Min (dBc)	Result
1	2390.0 (Unrestricted, Peak)	-35.08	8.84	43.92	20	PASS
1	2390.0 (Unrestricted, Average)	-39.99	4.47	44.46	20	PASS
11	2483.5 (Unrestricted, Peak)	-44.69	7.72	52.40	20	PASS
11	2483.5 (Unrestricted, Average)	-51.59	4.11	55.70	20	PASS

CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBm)	Corrected Emission Level (dBm)	Limit* (dBm)	Gain (dBi)	Margin	Result
1	2340.0 (Restricted, Peak)	-43.20	-43.20	-21.23	N/A	21.97	PASS
1	2340.0 (Restricted, Average)	-47.50	-47.50	-41.23	N/A	6.27	PASS
11	2483.5 (Restricted, Peak)	-41.86	-41.86	-21.23	N/A	20.63	PASS
11	2483.5 (Restricted, Average)	-43.26	-43.26	-41.23	N/A	2.03	PASS

Corrected Emission level= Highest out of band level +Gain

Margin= Limit-Corrected Emission Level

*Limits from Part 15.209 in dBm **Antenna gain declared by the manufacturer

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

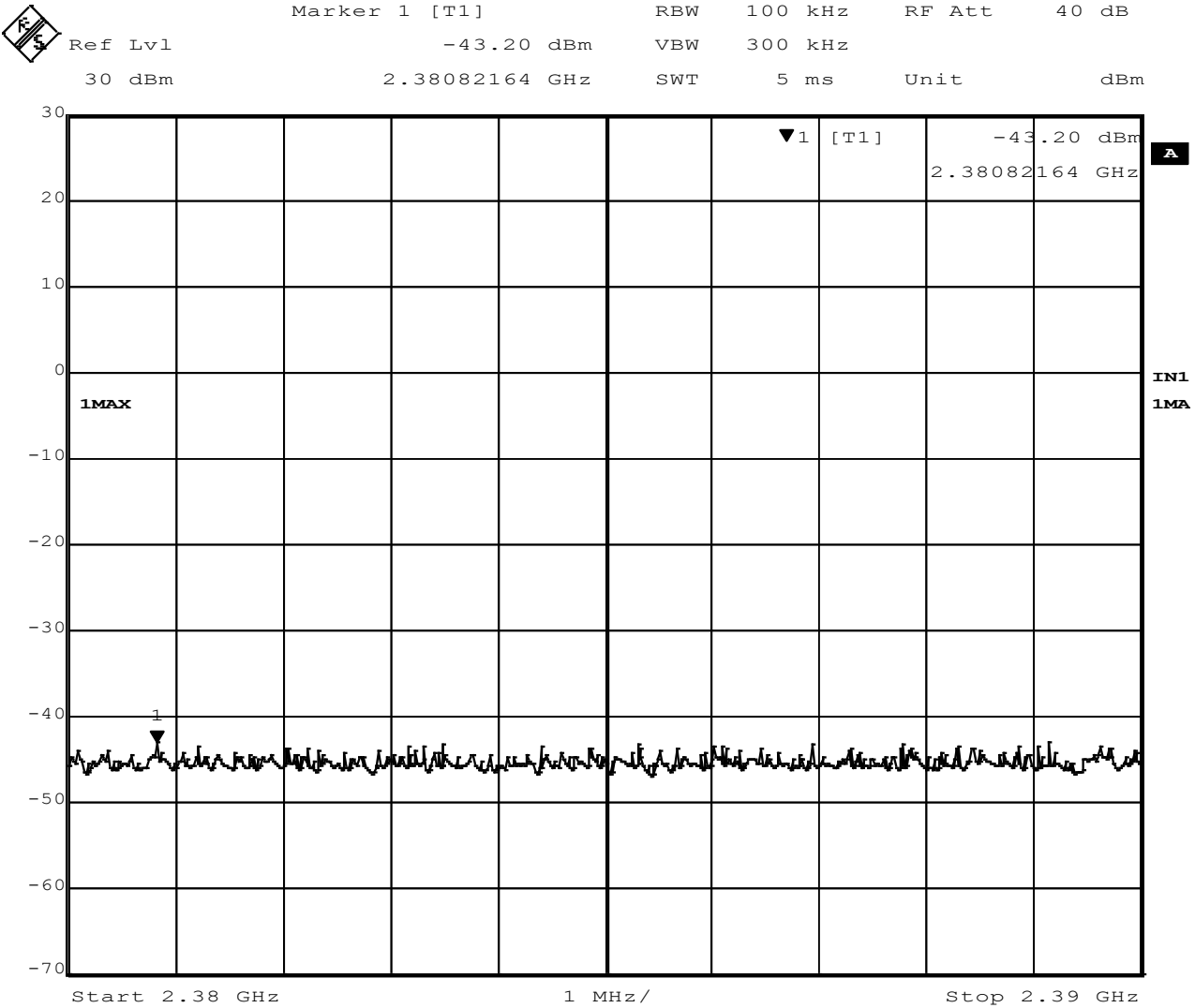


Figure 60 - Band-edge Measurement, Low Channel, Restricted Frequency, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

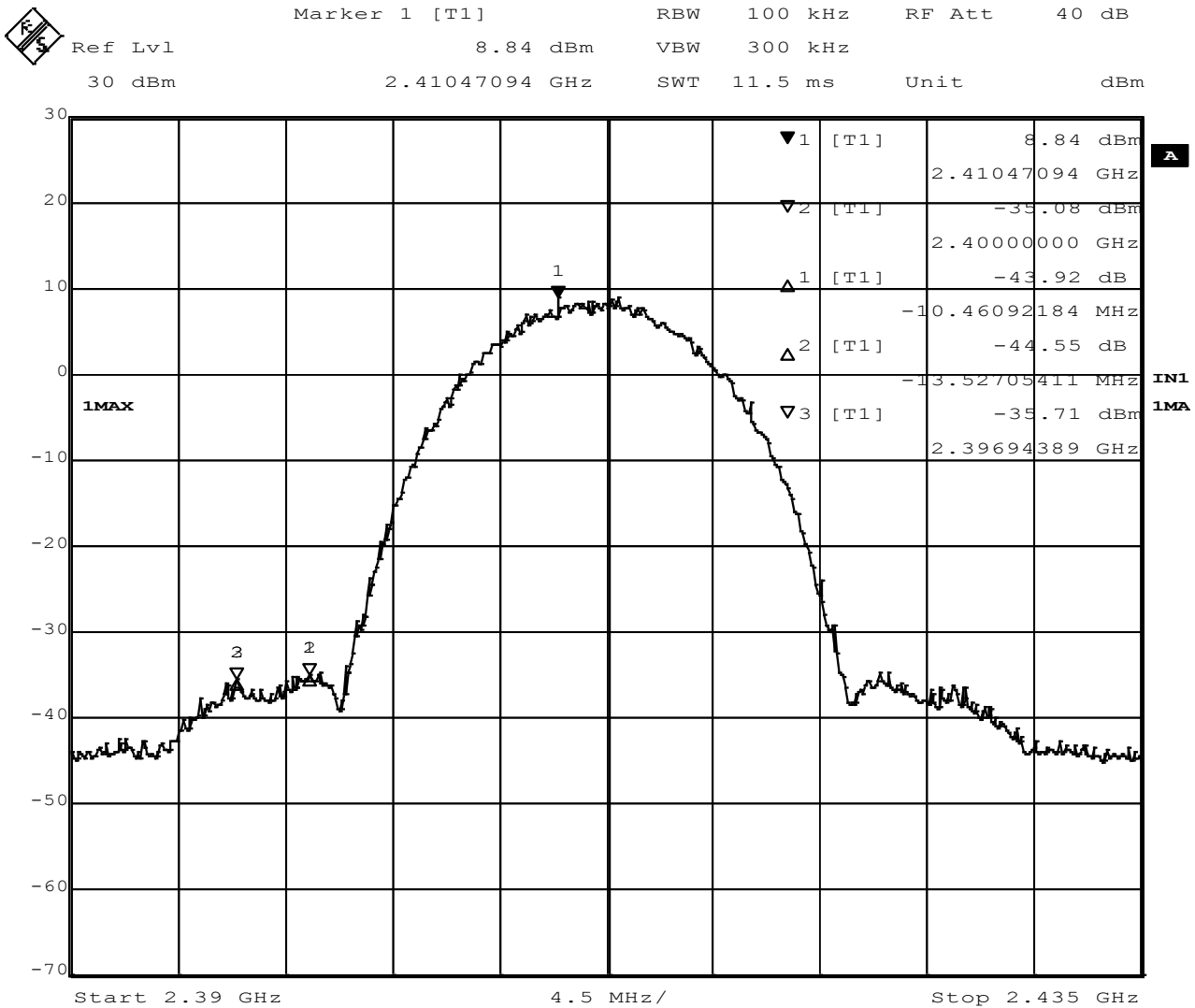


Figure 61 - Band-edge Measurement, Low Channel, Fundamental, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

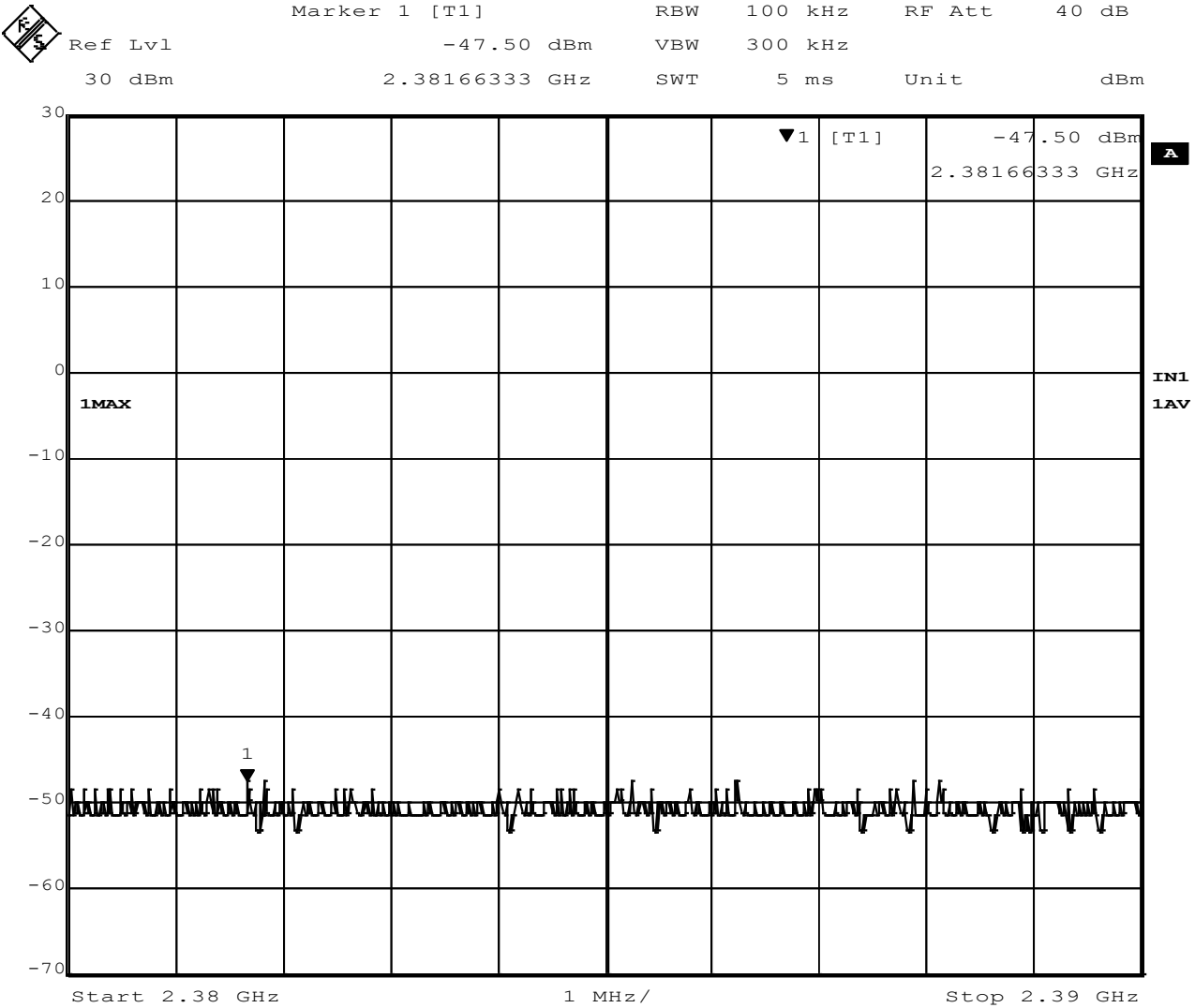


Figure 62 - Band-edge Measurement, Low Channel, Restricted Frequency, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

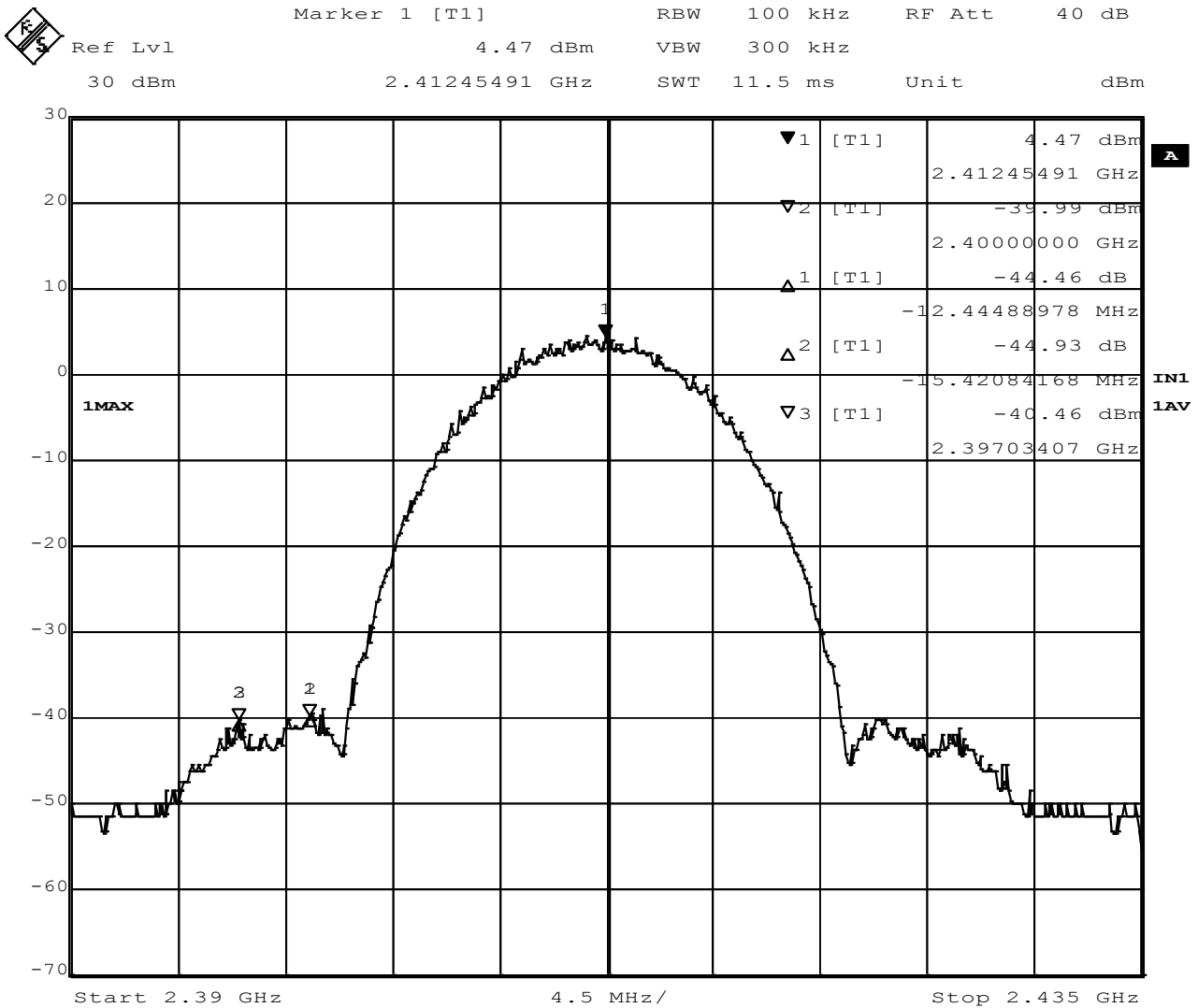


Figure 63 - Band-edge Measurement, Low Channel, Fundamental, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

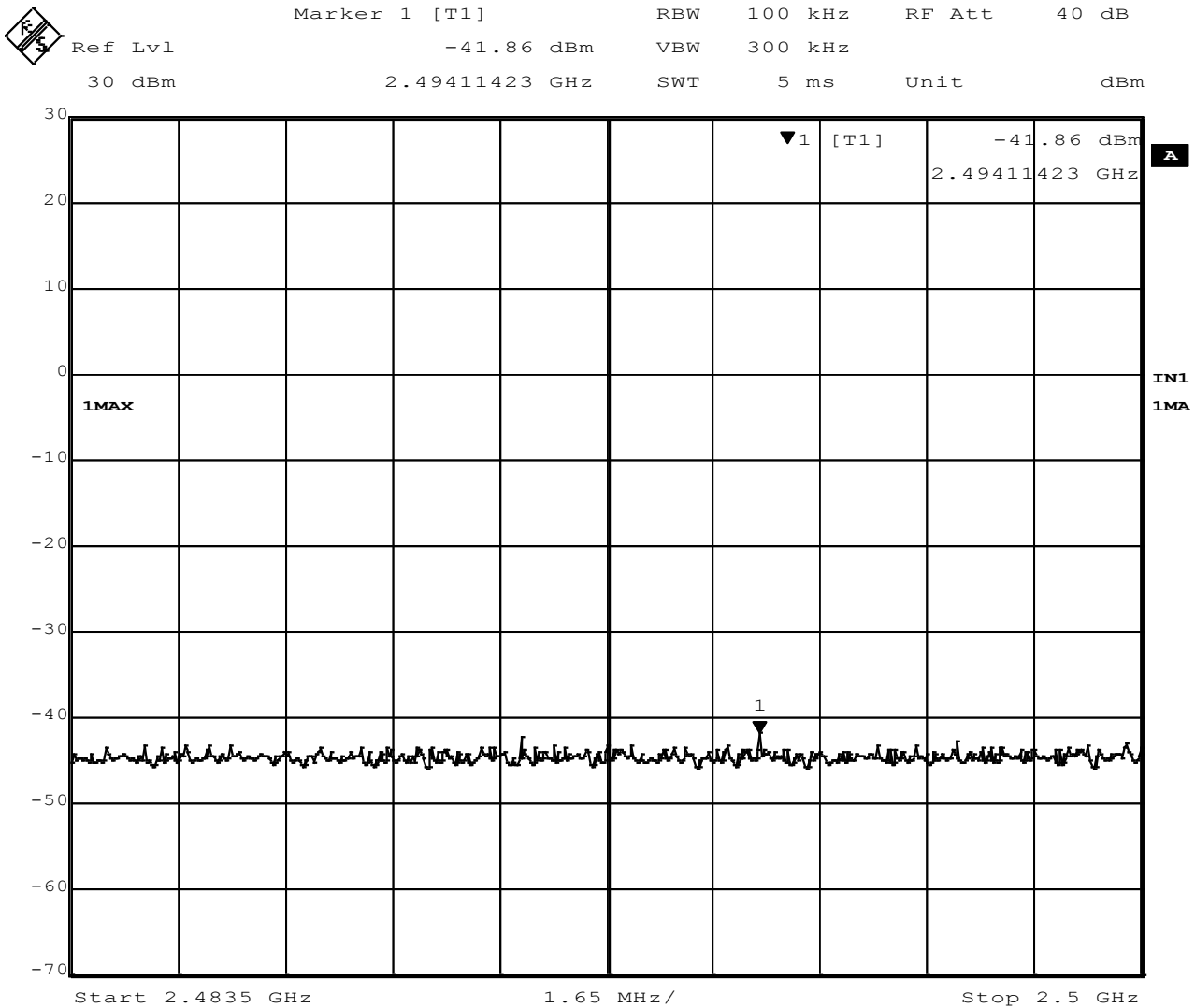


Figure 64 - Band-edge Measurement, High Channel, Restricted Frequency, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

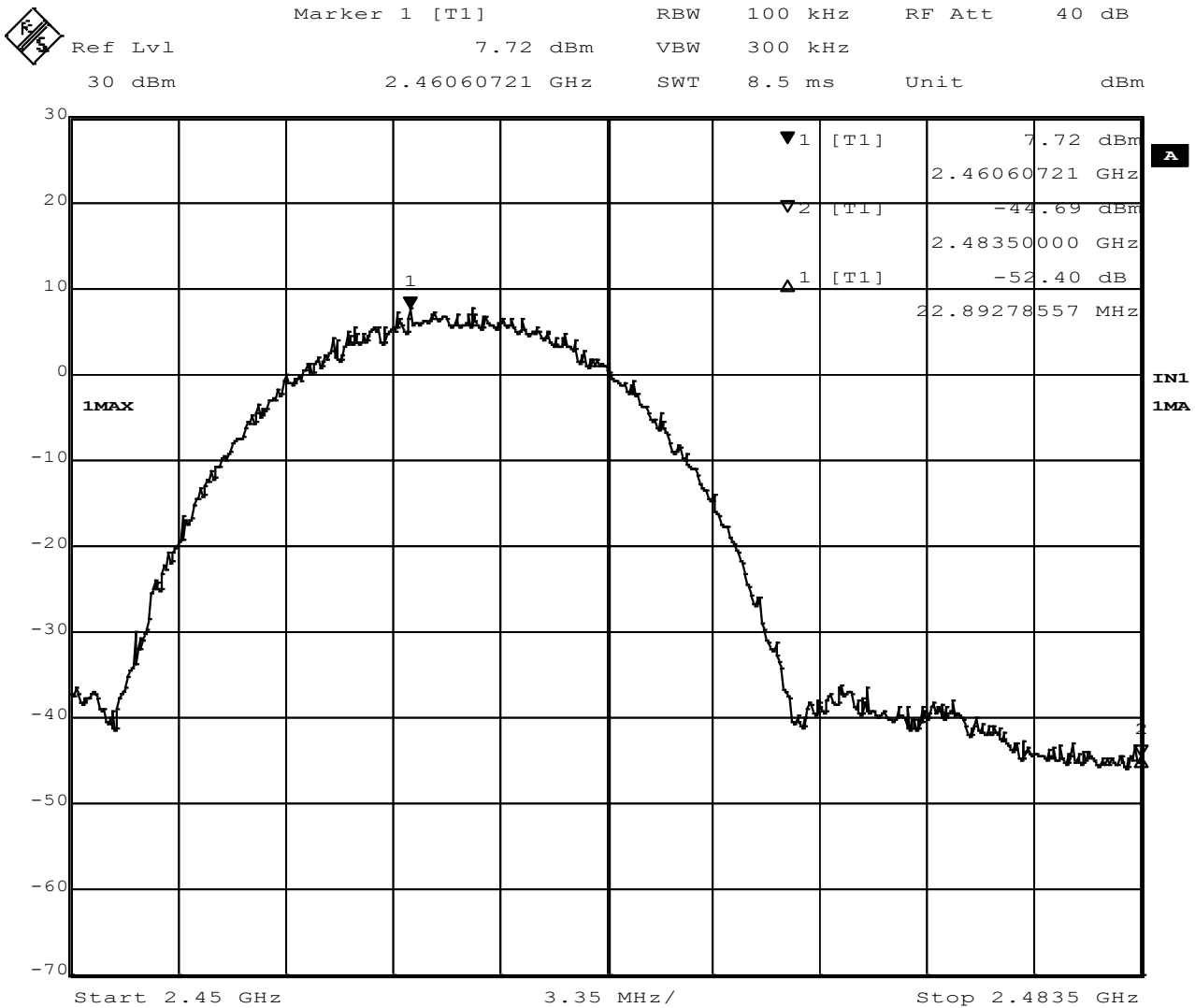
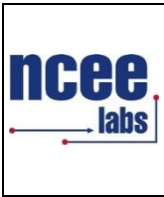


Figure 65 - Band-edge Measurement, High Channel, Fundamental, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

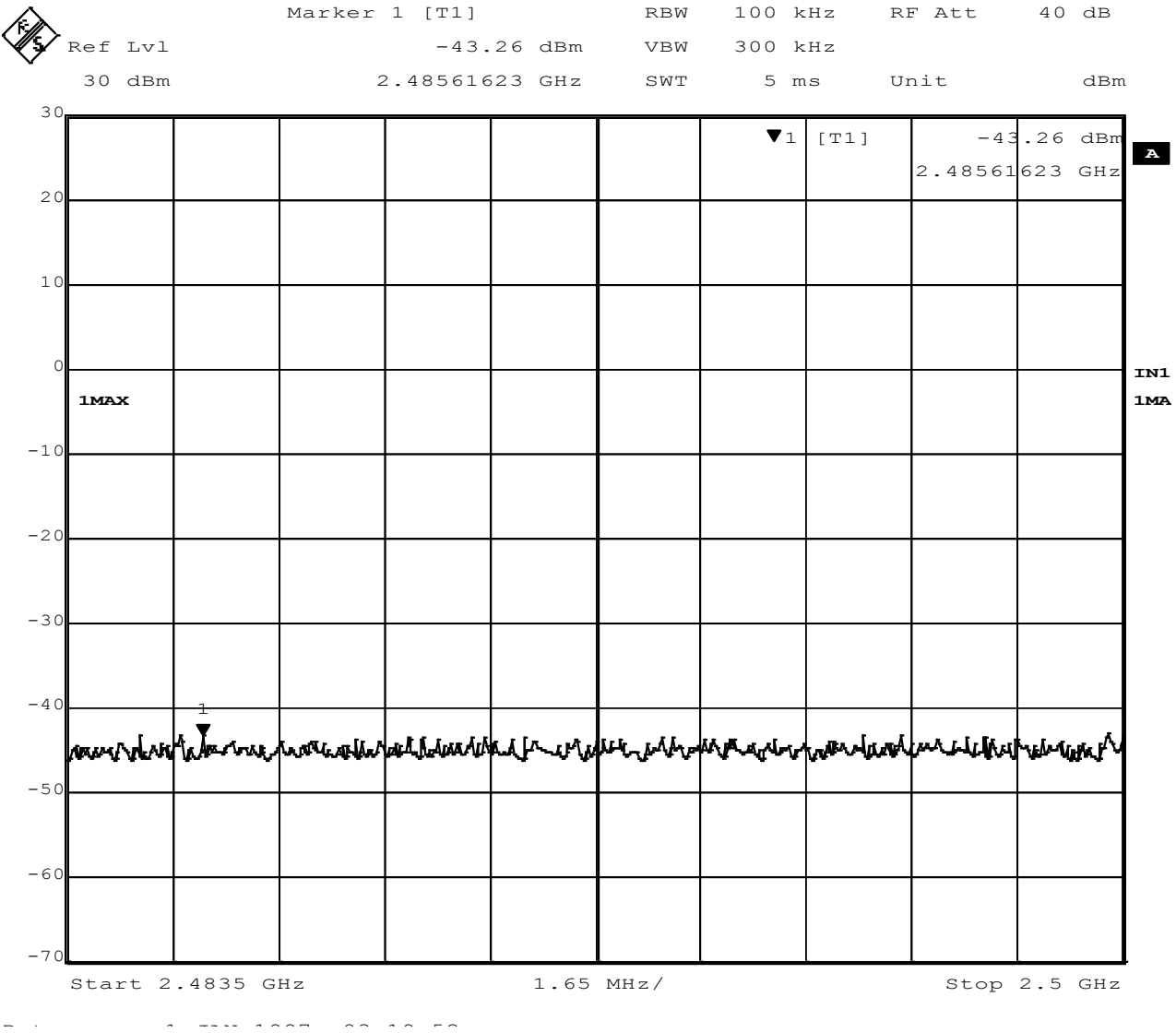


Figure 66 - Band-edge Measurement, High Channel, Restricted Frequency, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

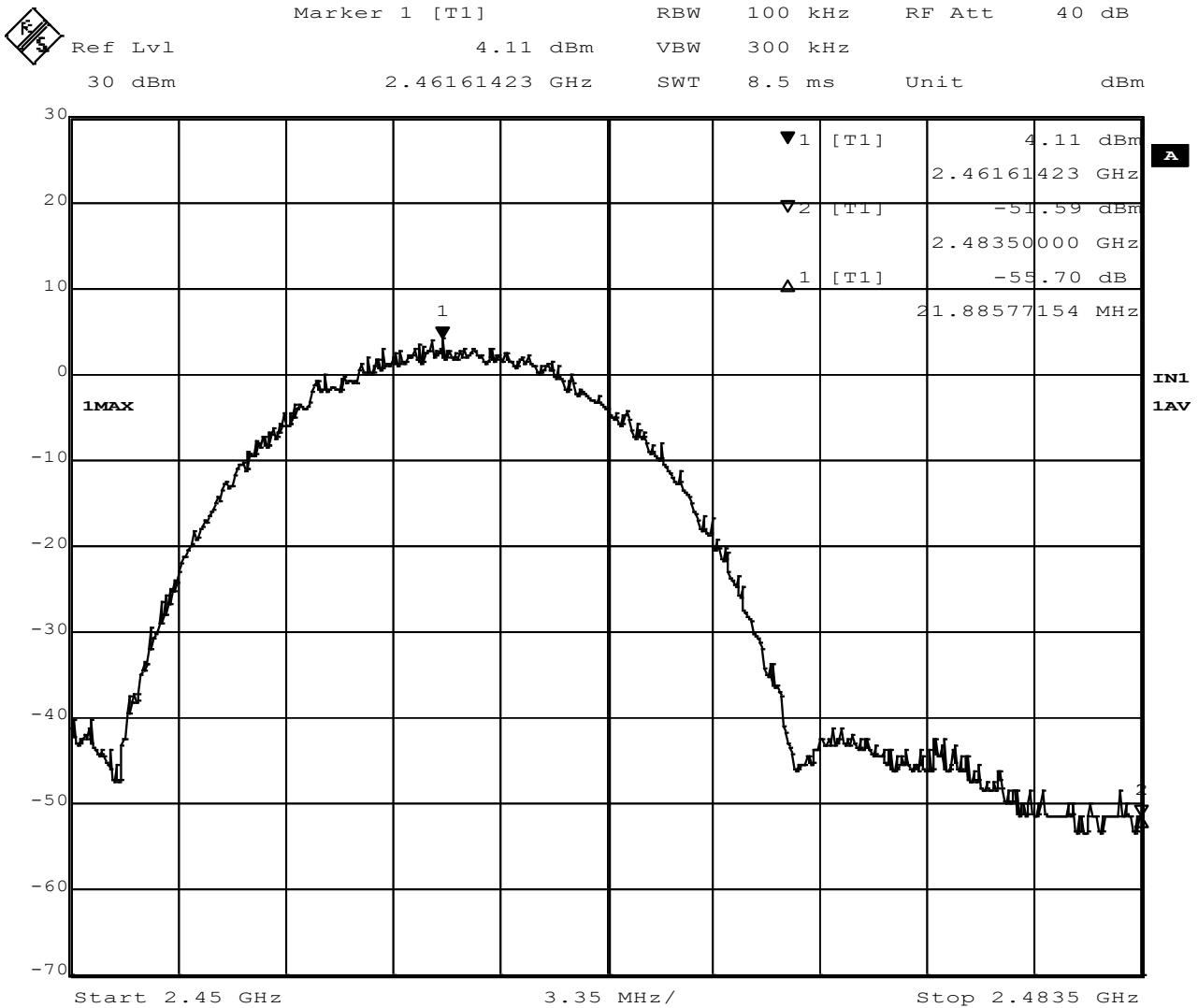


Figure 67 - Band-edge Measurement, High Channel, Fundamental, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

Highest Out of Band Emissions, 802.11g

CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level dBm	Fundamental Level (dBm)	Delta	Min (dBc)	Result
1	2390.0 (Unrestricted, Peak)	-35.96	3.41	39.37	20	PASS
1	2390.0 (Unrestricted, Average)	-42.04	-1.49	40.55	20	PASS
11	2483.5 (Unrestricted, Peak)	-43.42	3.40	46.82	20	PASS
11	2483.5 (Unrestricted, Average)	-48.66	-0.70	47.96	20	PASS

CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBm)	Corrected Emission Level (dBm)	Limit* (dBm)	Gain (dBi) ***	Margin	Result
1	2340.0 (Restricted, Peak)	-39.72	-39.72	-21.23	N/A	18.49	PASS
1	2340.0 (Restricted, Average)	-43.98	-43.98	-41.23	N/A	2.75	PASS
11	2483.5 (Restricted, Peak)	-41.56	-41.56	-21.23	N/A	20.33	PASS
11	2483.5 (Restricted, Average)	-45.57	-45.57	-41.23	N/A	4.34	PASS

Corrected Emission level= Highest out of band level +Gain

Margin= Limit-Corrected Emission Level

*Limits from Part 15.209 in dBm **Antenna gain declared by the manufacturer

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

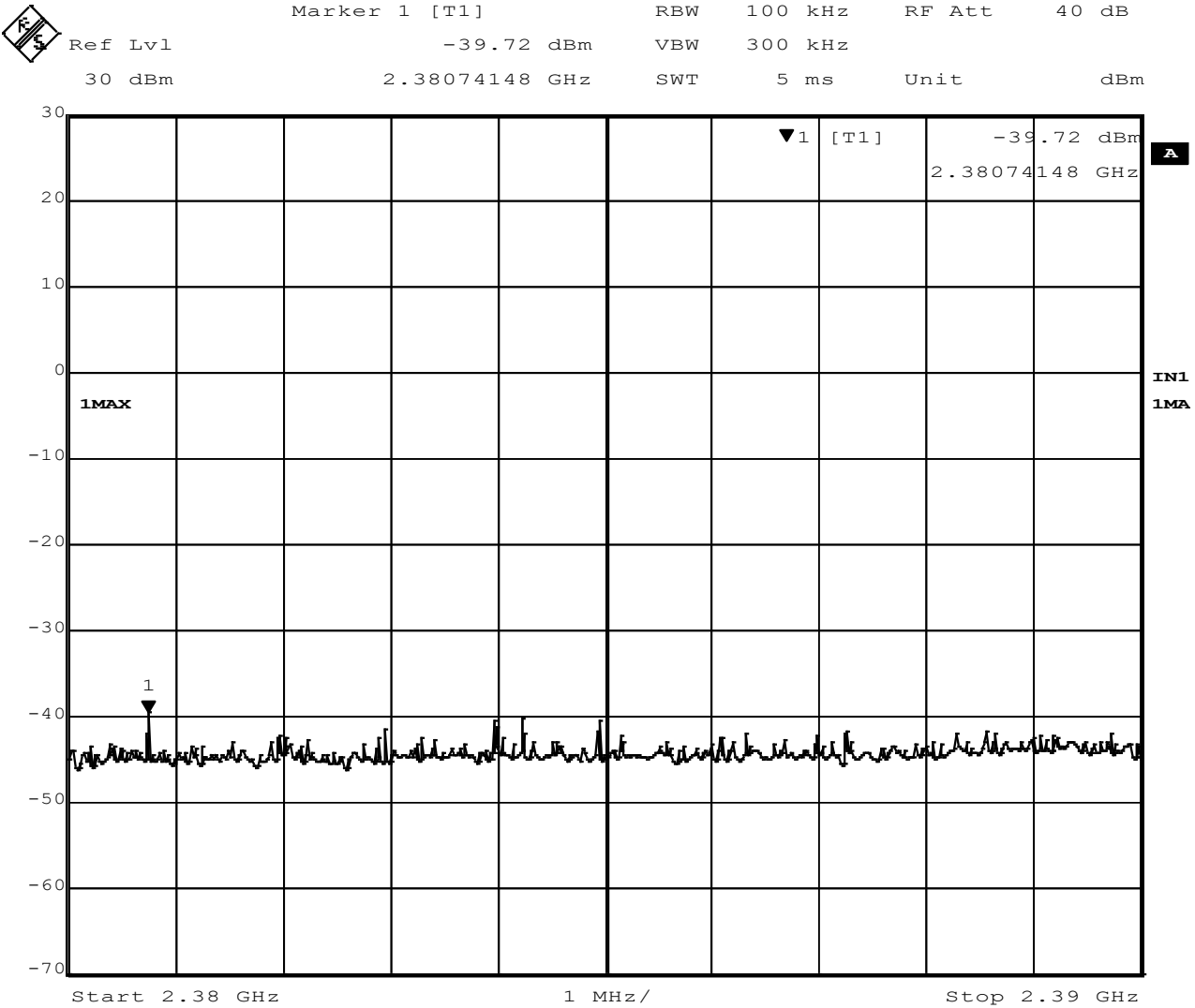


Figure 68 - Band-edge Measurement, Low Channel, Restricted Frequency, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

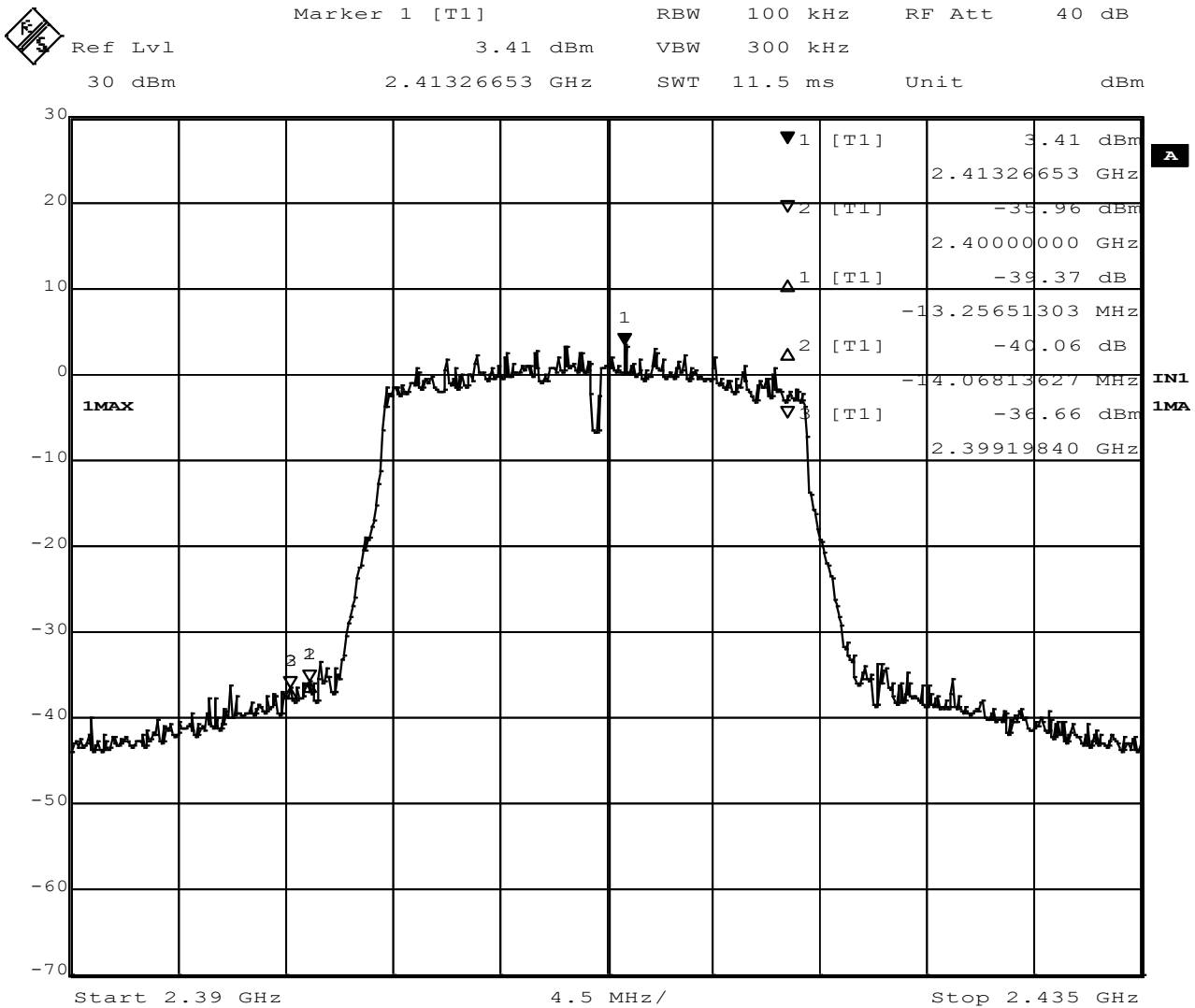


Figure 69 - Band-edge Measurement, Low Channel, Fundamental, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

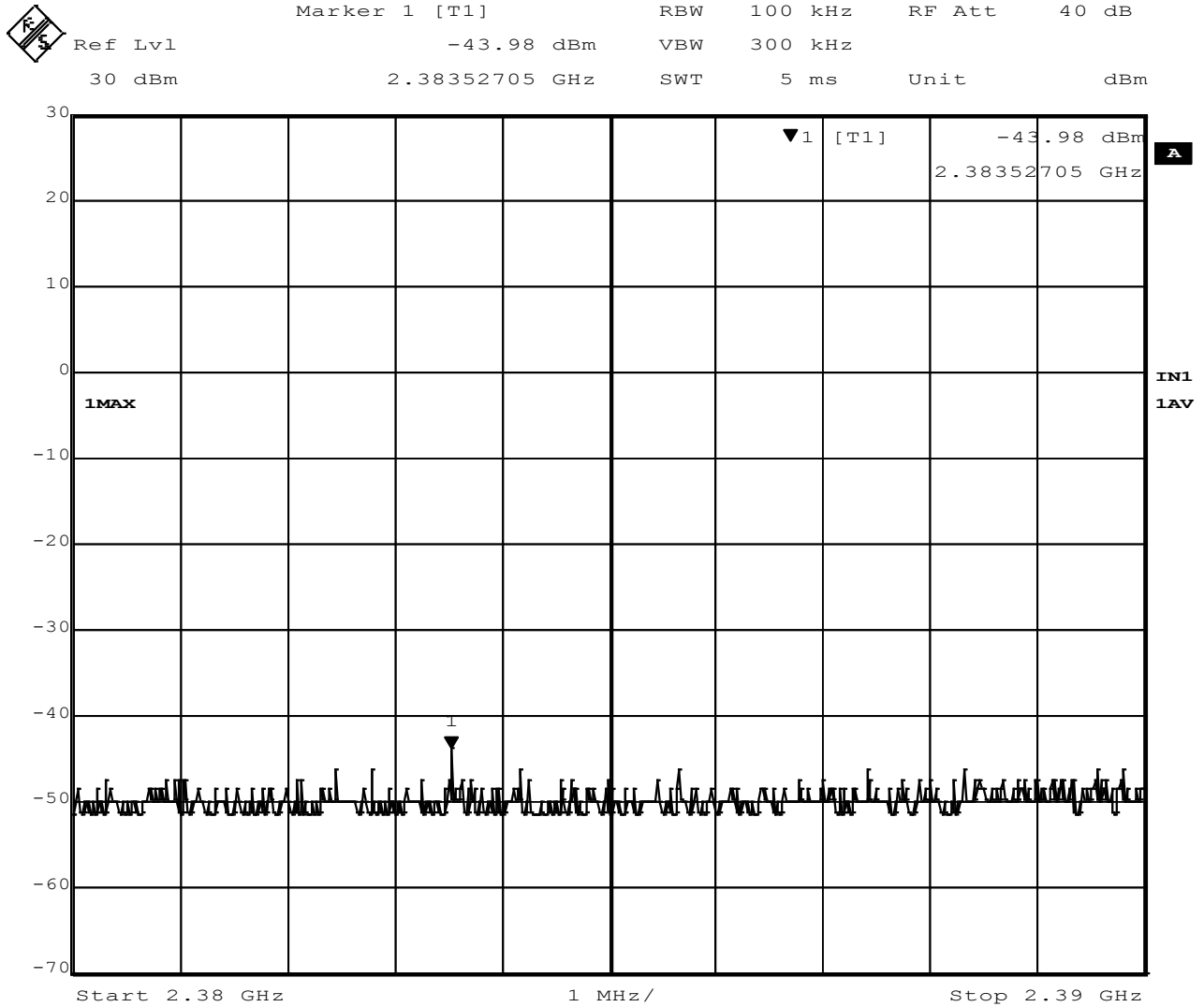


Figure 70 - Band-edge Measurement, Low Channel, Restricted Frequency, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

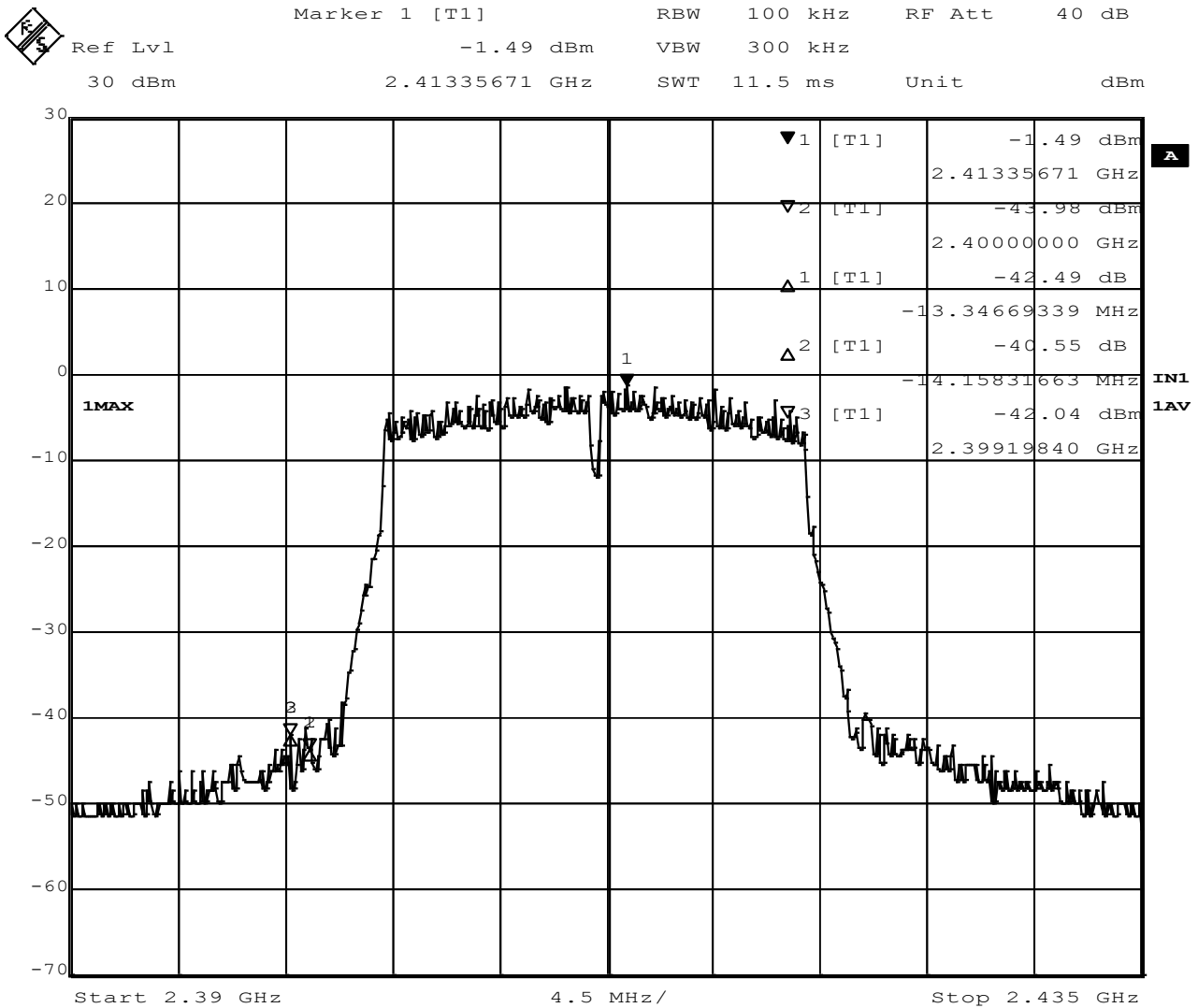


Figure 71 - Band-edge Measurement, Low Channel, Fundamental, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

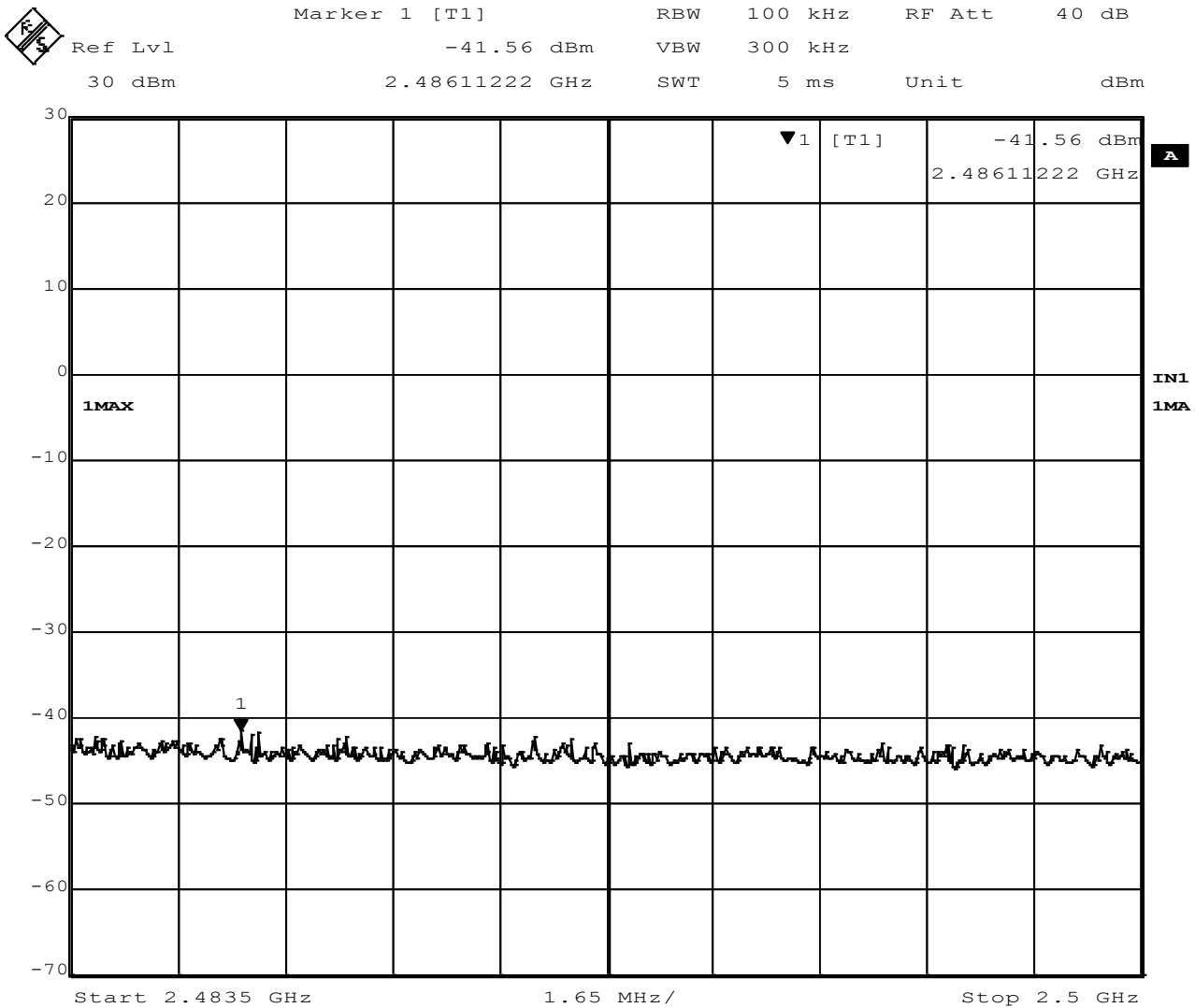
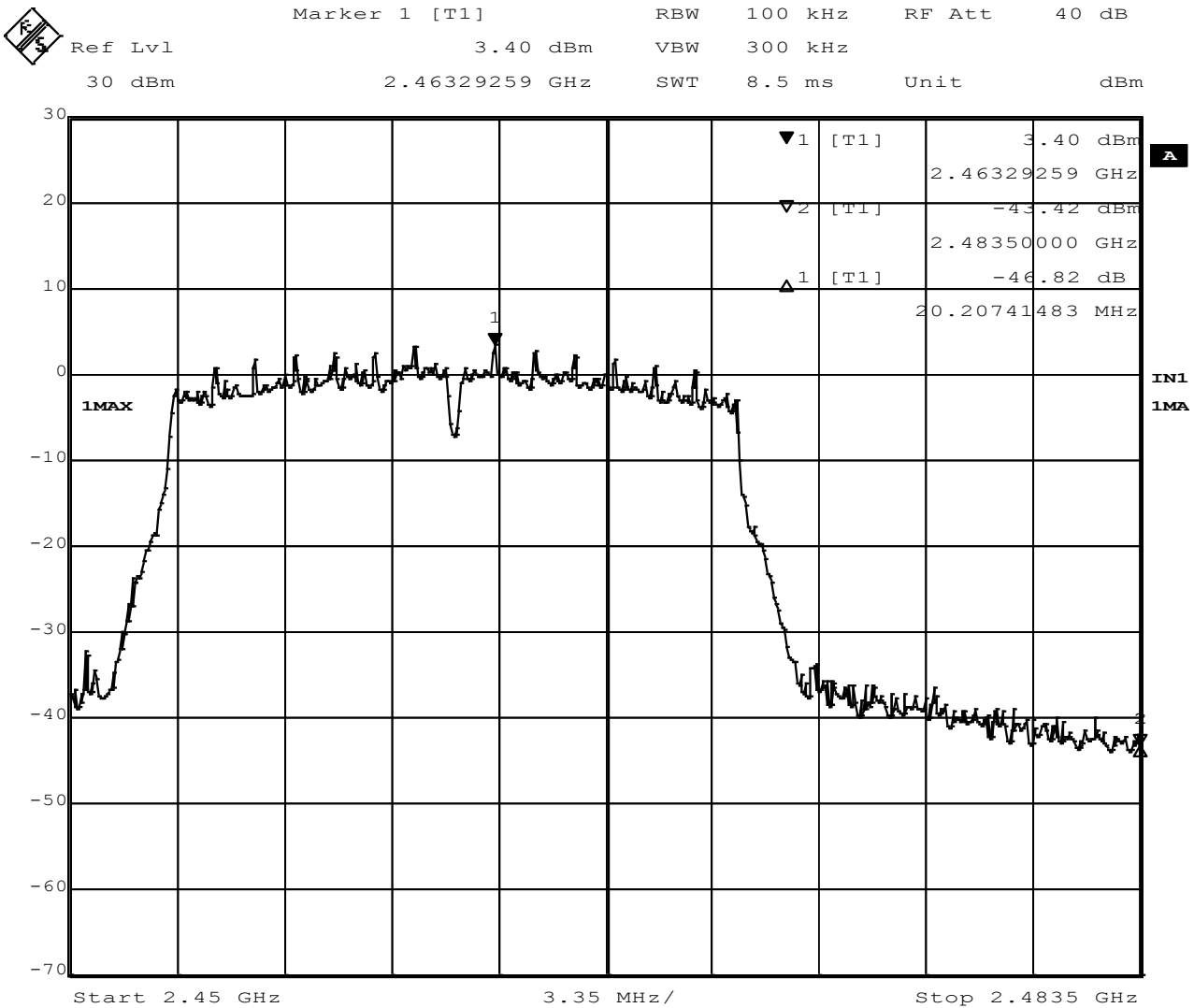


Figure 72 - Band-edge Measurement, High Channel, Restricted Frequency, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		



▼1 [T1]

3.40 dBm

2.46329259 GHz

▼2 [T1]

-43.42 dBm

2.48350000 GHz

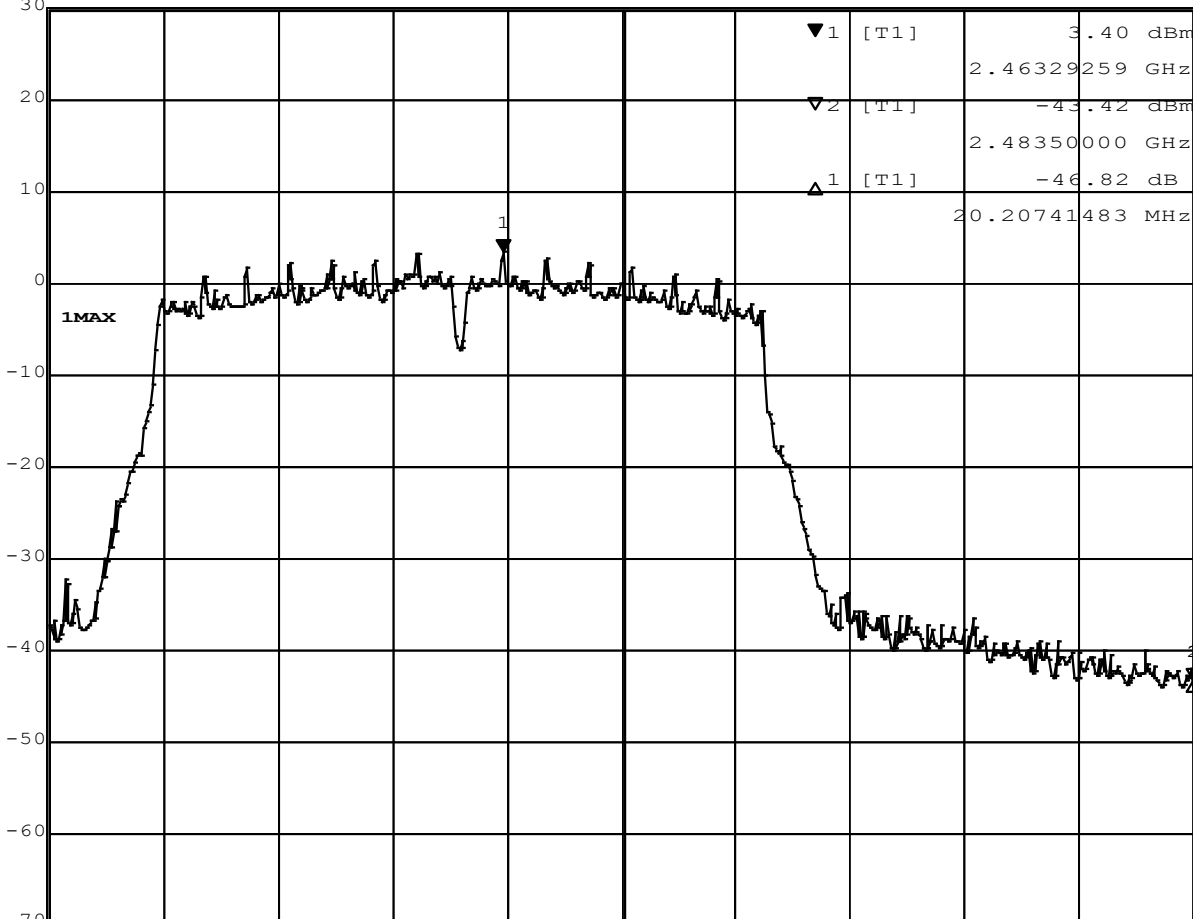
▲1 [T1]

-46.82 dB

20.20741483 MHz

IN1

1MA

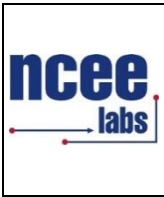


Start 2.45 GHz

3.35 MHz/

Stop 2.4835 GHz

Figure 73 - Band-edge Measurement, High Channel, Fundamental, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

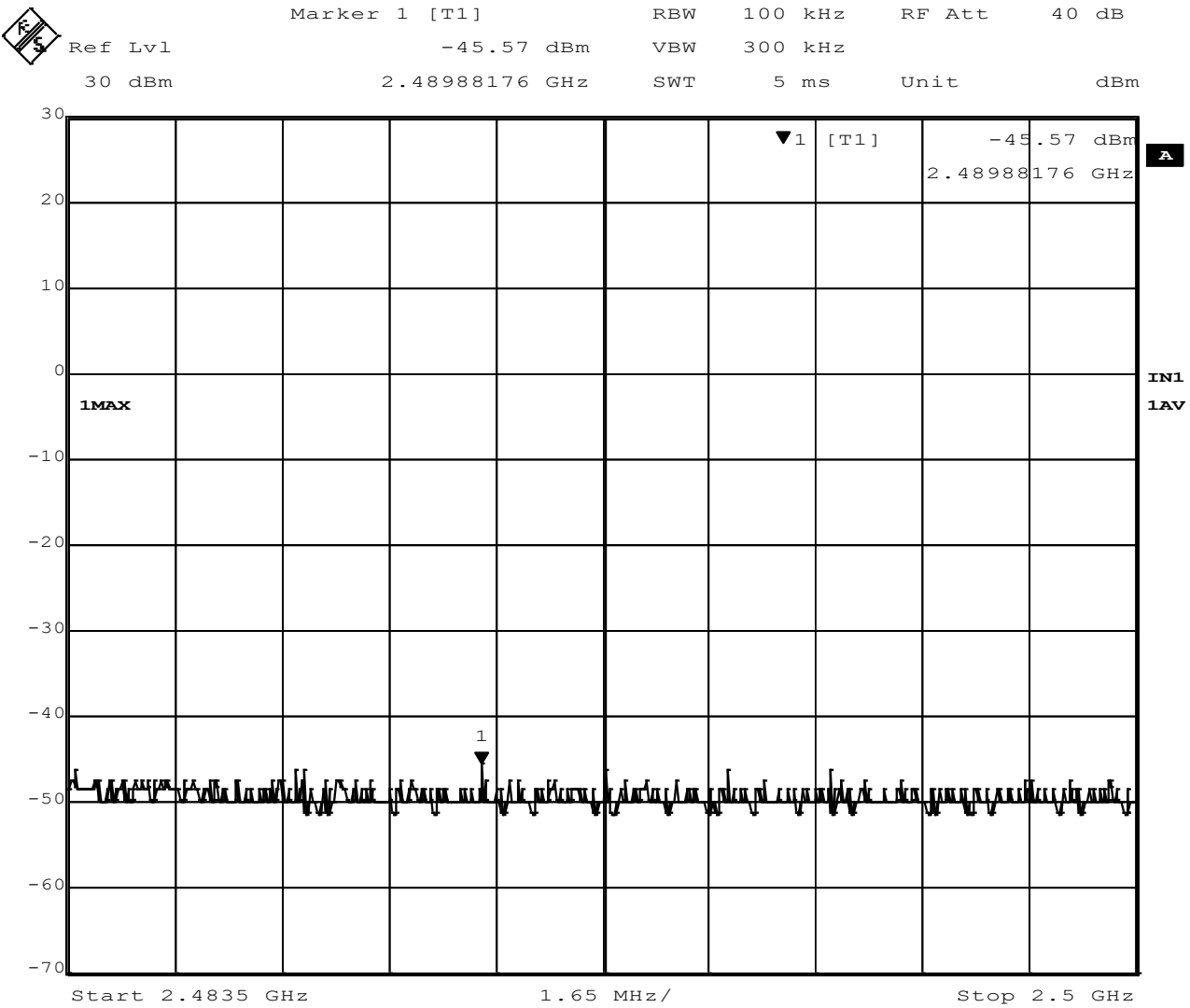


Figure 74 - Band-edge Measurement, High Channel, Restricted Frequency, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

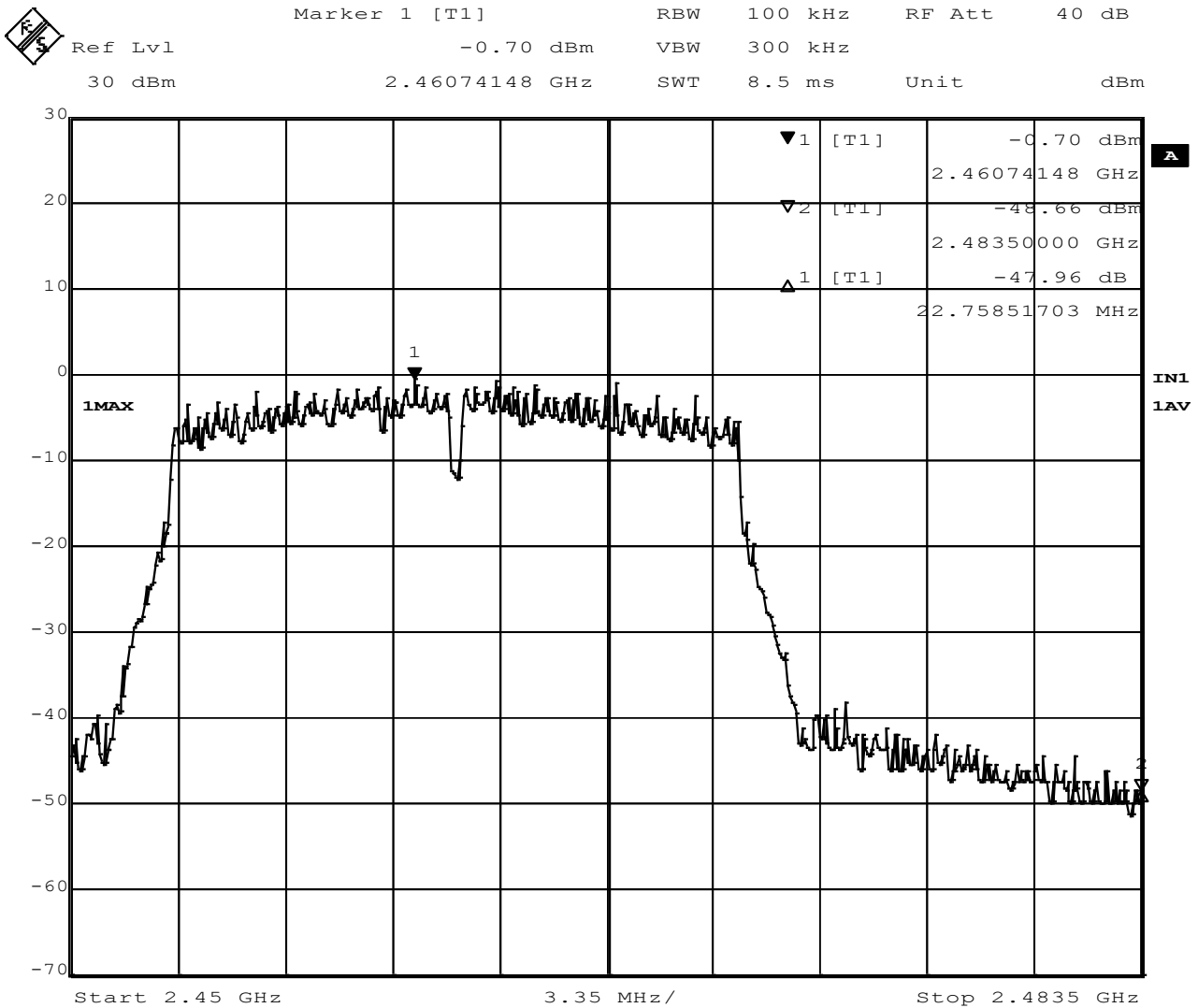


Figure 75 - Band-edge Measurement, High Channel, Fundamental, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

Highest Out of Band Emissions, 802.11n

CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level dBm	Fundamental Level (dBm)	Delta	Min (dBc)	Result
1	2390.0 (Unrestricted, Peak)	-36.56	3.48	40.04	20	PASS
1	2390.0 (Unrestricted, Average)	-42.04	-1.27	40.77	20	PASS
11	2483.5 (Unrestricted, Peak)	-43.50	3.27	46.77	20	PASS
11	2483.5 (Unrestricted, Average)	-50.00	0.72	50.72	20	PASS

CHANNEL	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBm)	Corrected Emission Level (dBm)	Limit* (dBm)	Gain** (dBi)	Margin	Result
1	2340.0 (Restricted, Peak)	-41.26	-41.26	-21.23	N/A	20.03	PASS
1	2340.0 (Restricted, Average)	-46.48	-46.48	-41.23	N/A	5.25	PASS
11	2483.5 (Restricted, Peak)	-41.18	-41.18	-21.23	N/A	19.95	PASS
11	2483.5 (Restricted, Average)	-45.57	-45.57	-41.23	N/A	4.34	PASS

Corrected Emission level= Highest out of band level +Gain

Margin= Limit-Corrected Emission Level

*Limits from Part 15.209 in dBm **Antenna gain declared by the manufacturer

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

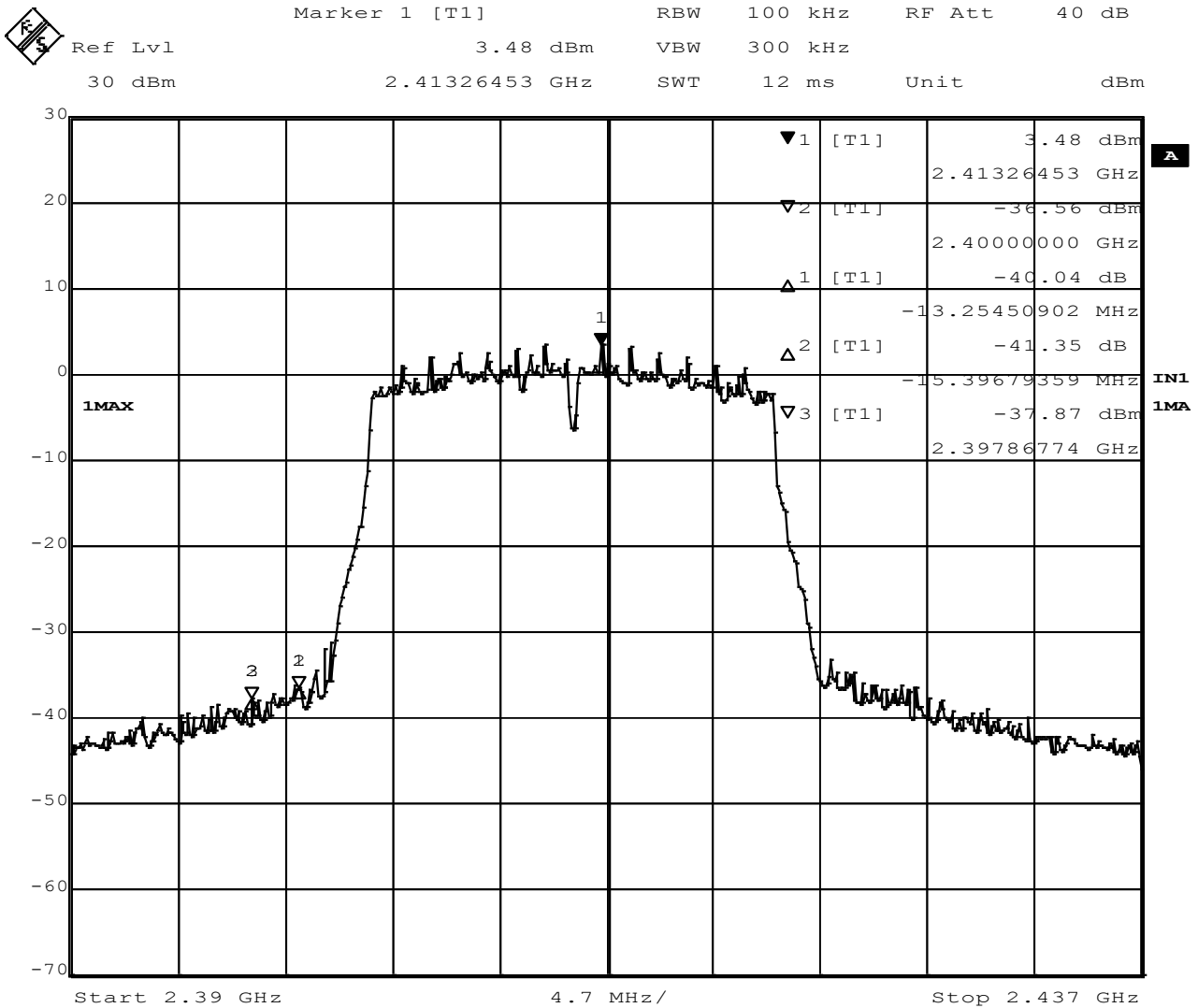


Figure 77 - Band-edge Measurement, Low Channel, Fundamental, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

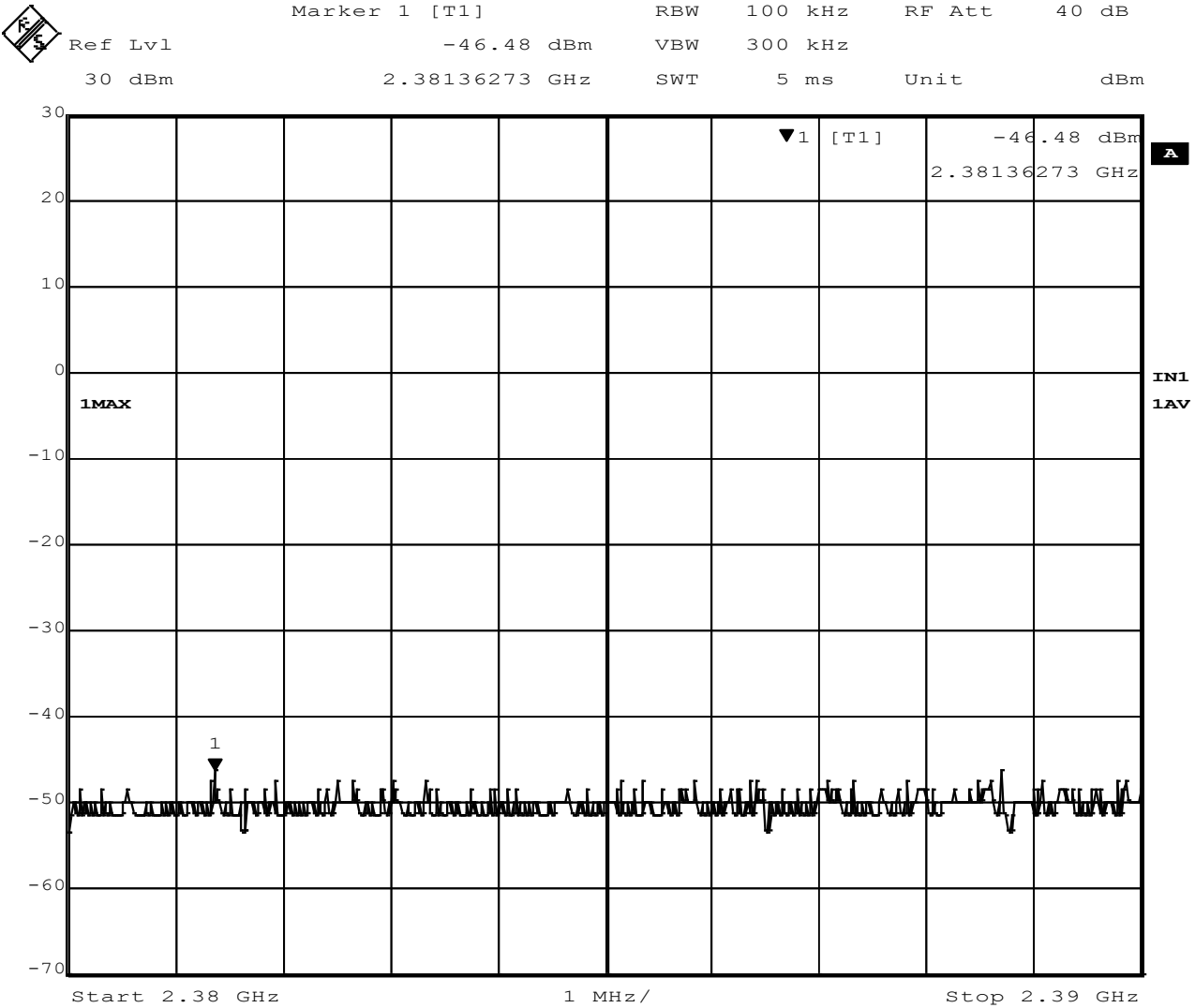
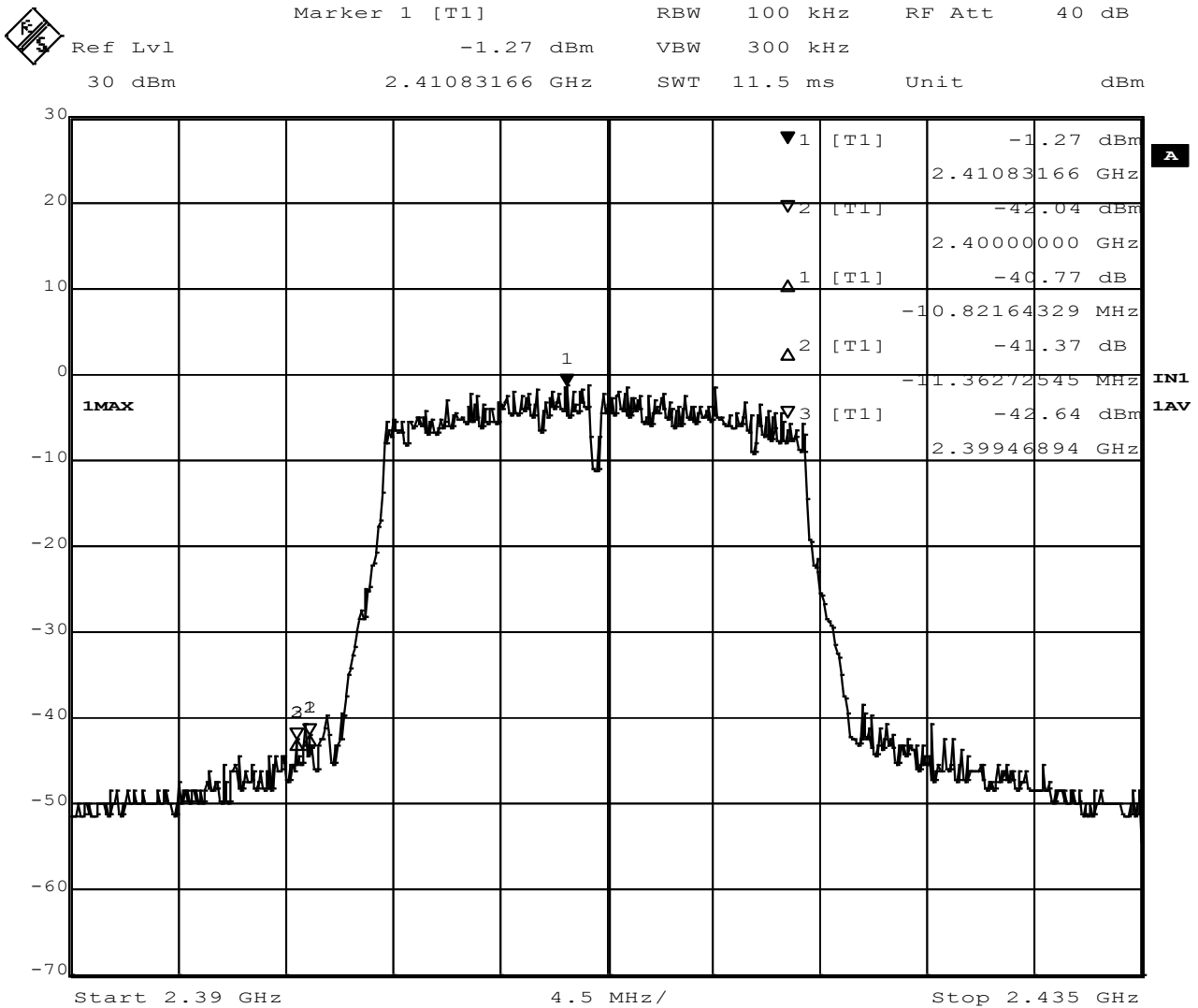


Figure 78 - Band-edge Measurement, Low Channel, Restricted Frequency, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		



Date: 1 JAN 2007 03:36:45
 Figure 79 - Band-edge Measurement, Low Channel, Fundamental, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

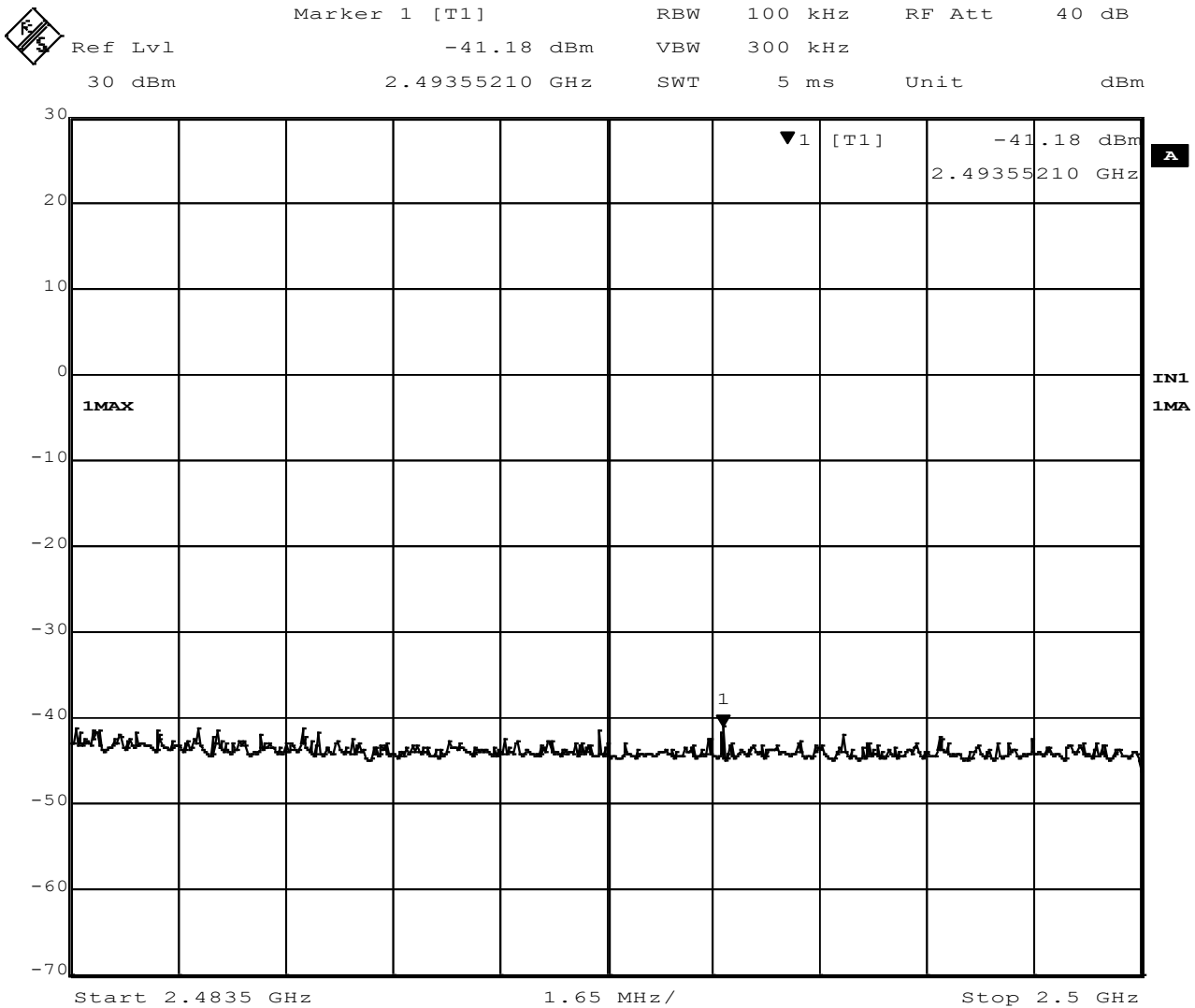


Figure 80 - Band-edge Measurement, High Channel, Restricted Frequency, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

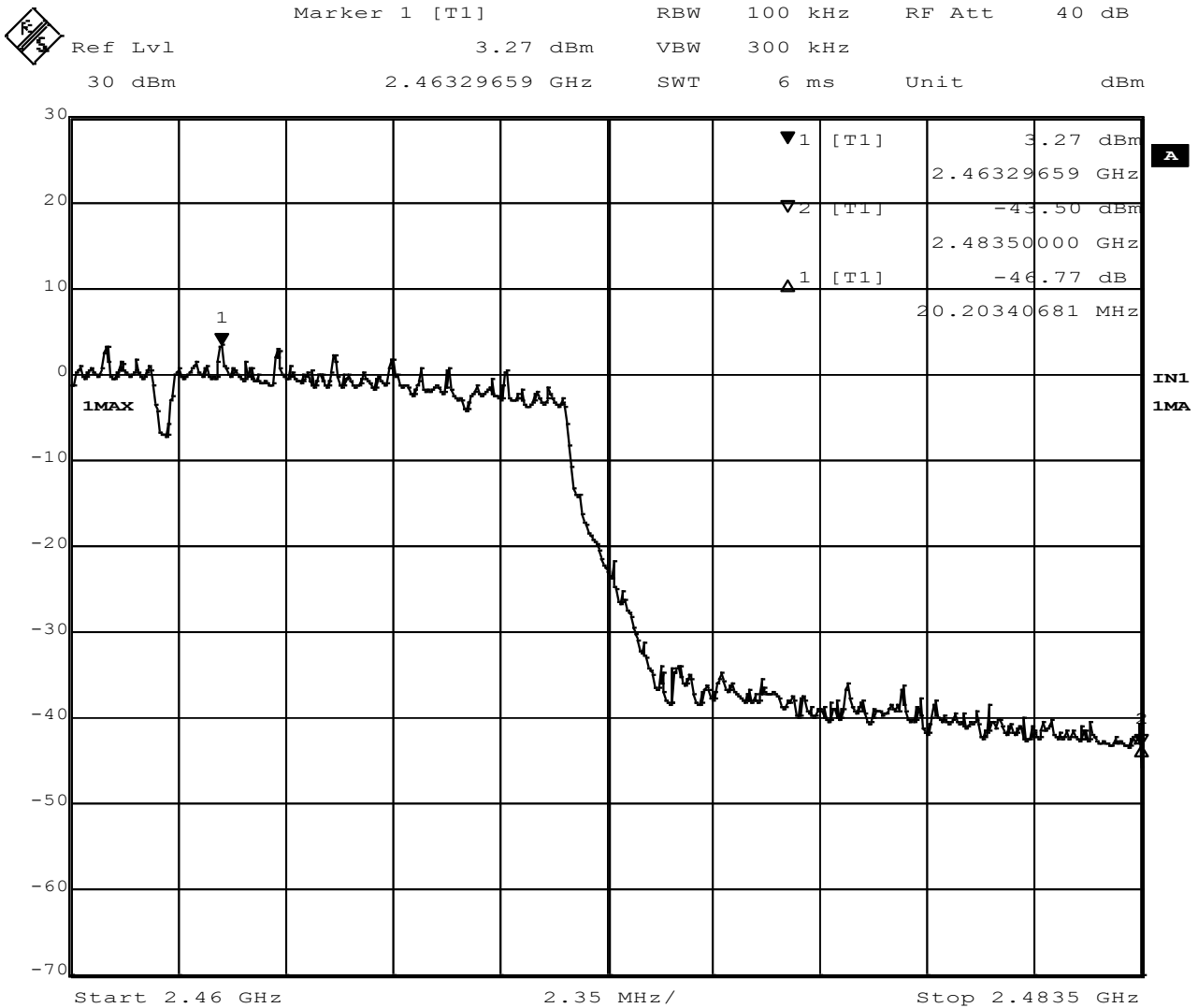


Figure 81 - Band-edge Measurement, High Channel, Fundamental, Peak

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

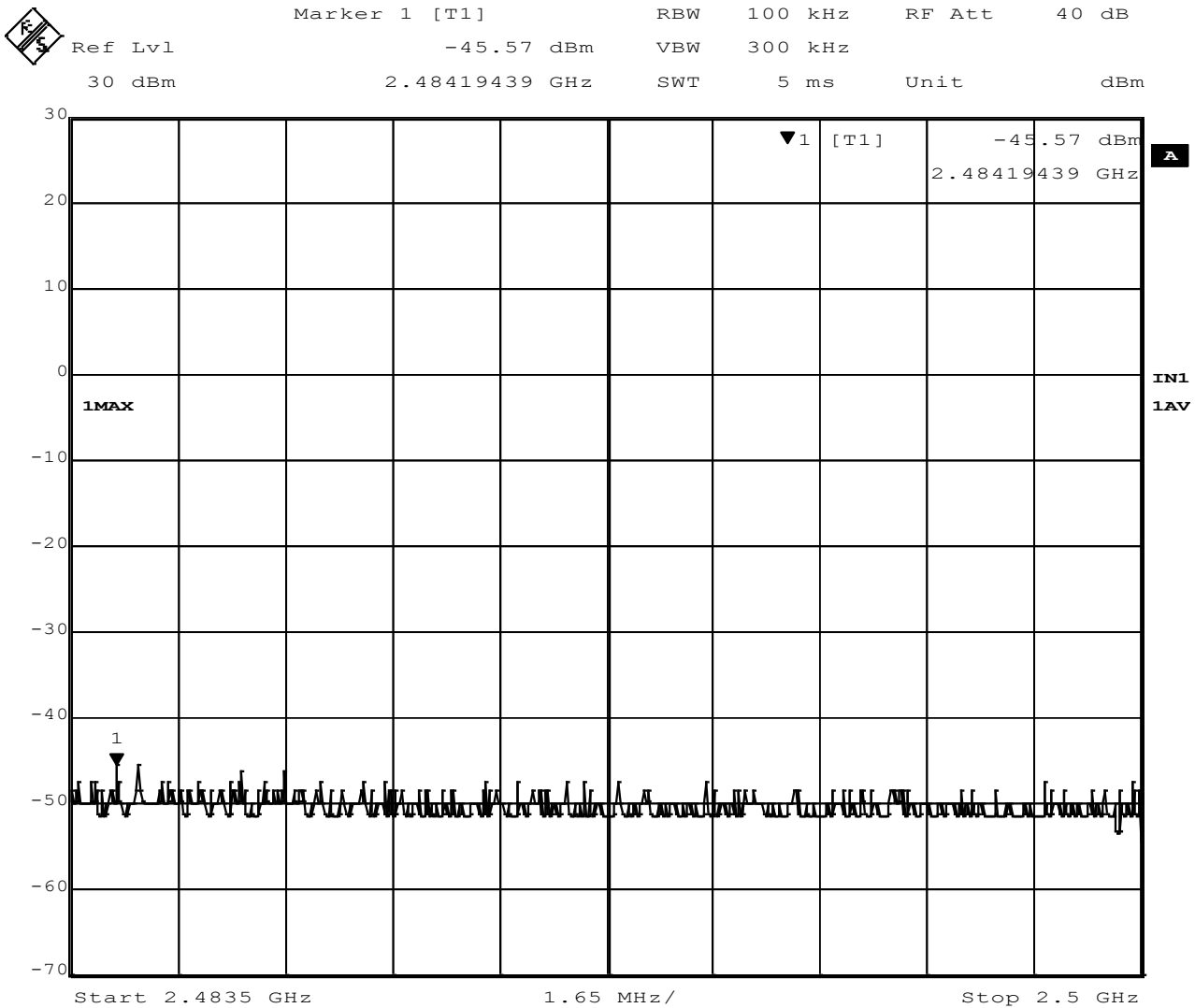


Figure 82 - Band-edge Measurement, High Channel, Restricted Frequency, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

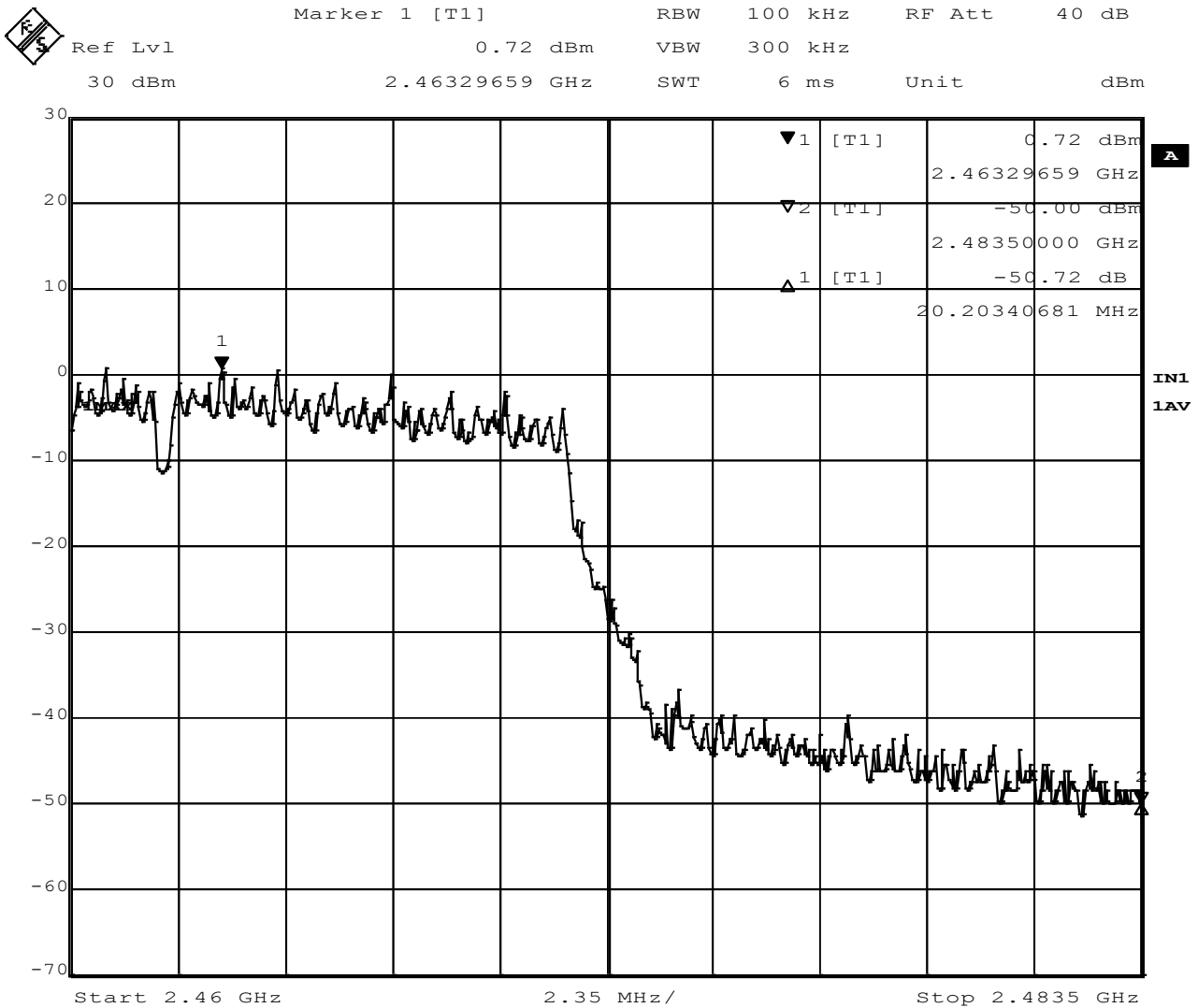


Figure 83 - Band-edge Measurement, High Channel, Fundamental, Average

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

4.6 POWER SPECTRAL DENSITY

Test Method: ANSI C63.10,

1. Section 11.10.2 "Method PKPSD (peak PSD)"

Limits of power measurements:

The maximum PSD allowed is 8 dBm.

Test procedures:

1. The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable.
2. The resolution bandwidth was set to 3 kHz and the video bandwidth was set to 10 kHz to capture the signal. The analyzer used a peak detector in max hold mode.

Test setup:

The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable on a bench top.

EUT operating conditions:

The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

Test results:

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

Power Spectral Density

CHANNEL	CHANNEL FREQUENCY (MHz)	WIFI Type	PEAK PSD(dBm)	Method	Limit (dBm)	RESULT
Low	2412	802.11b	-6.42	Conducted	8.00	PASS
Middle	2437	802.11b	-7.08	Conducted	8.00	PASS
High	2462	802.11b	-7.62	Conducted	8.00	PASS
Low	2412	802.11g	-10.28	Conducted	8.00	PASS
Middle	2437	802.11g	-9.82	Conducted	8.00	PASS
High	2462	802.11g	-11.96	Conducted	8.00	PASS
Low	2412	802.11n	-12.21	Conducted	8.00	PASS
Middle	2437	802.11n	-9.05	Conducted	8.00	PASS
High	2462	802.11n	-12.63	Conducted	8.00	PASS

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

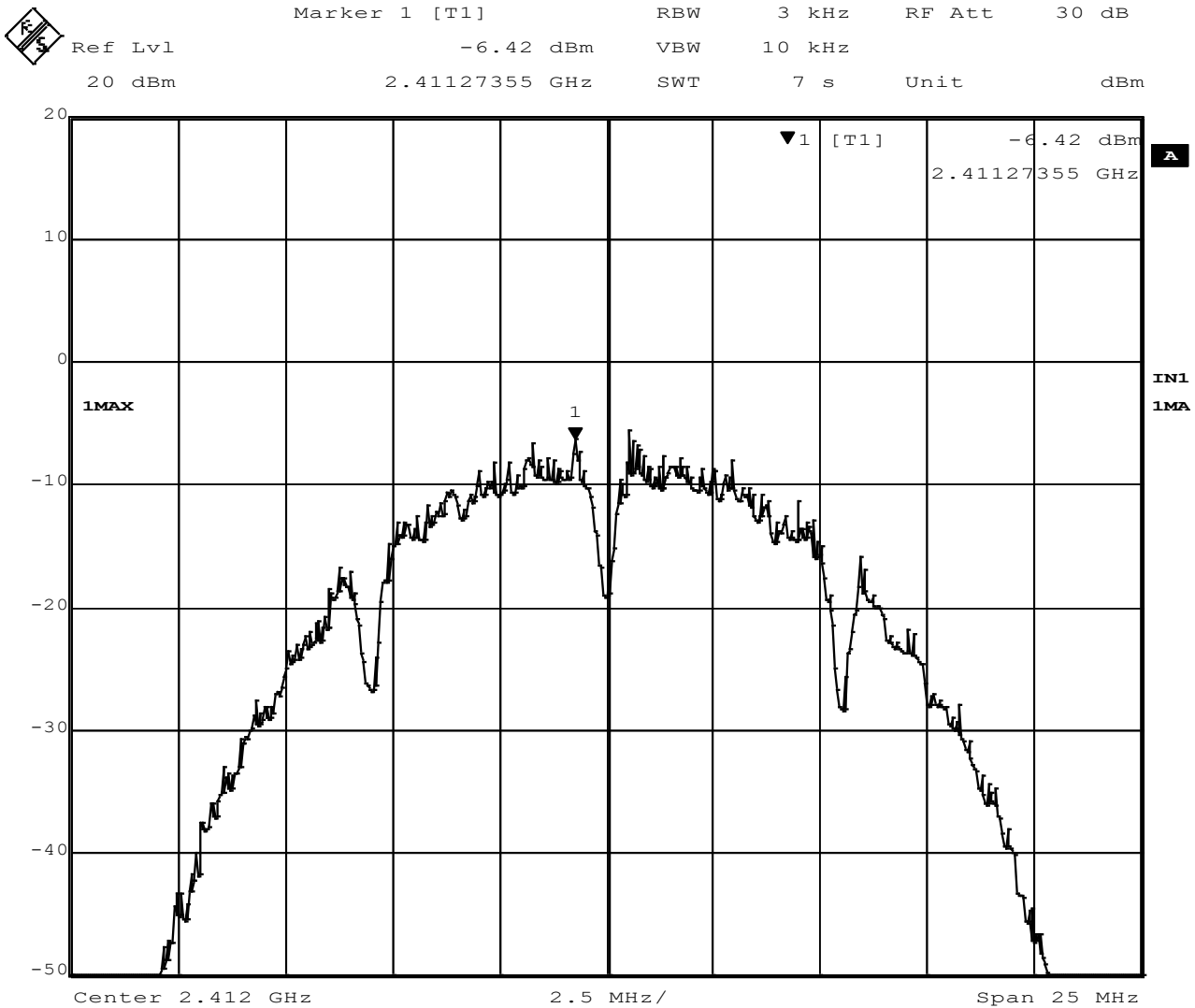


Figure 84 - Power Spectral Density, Low Channel, 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

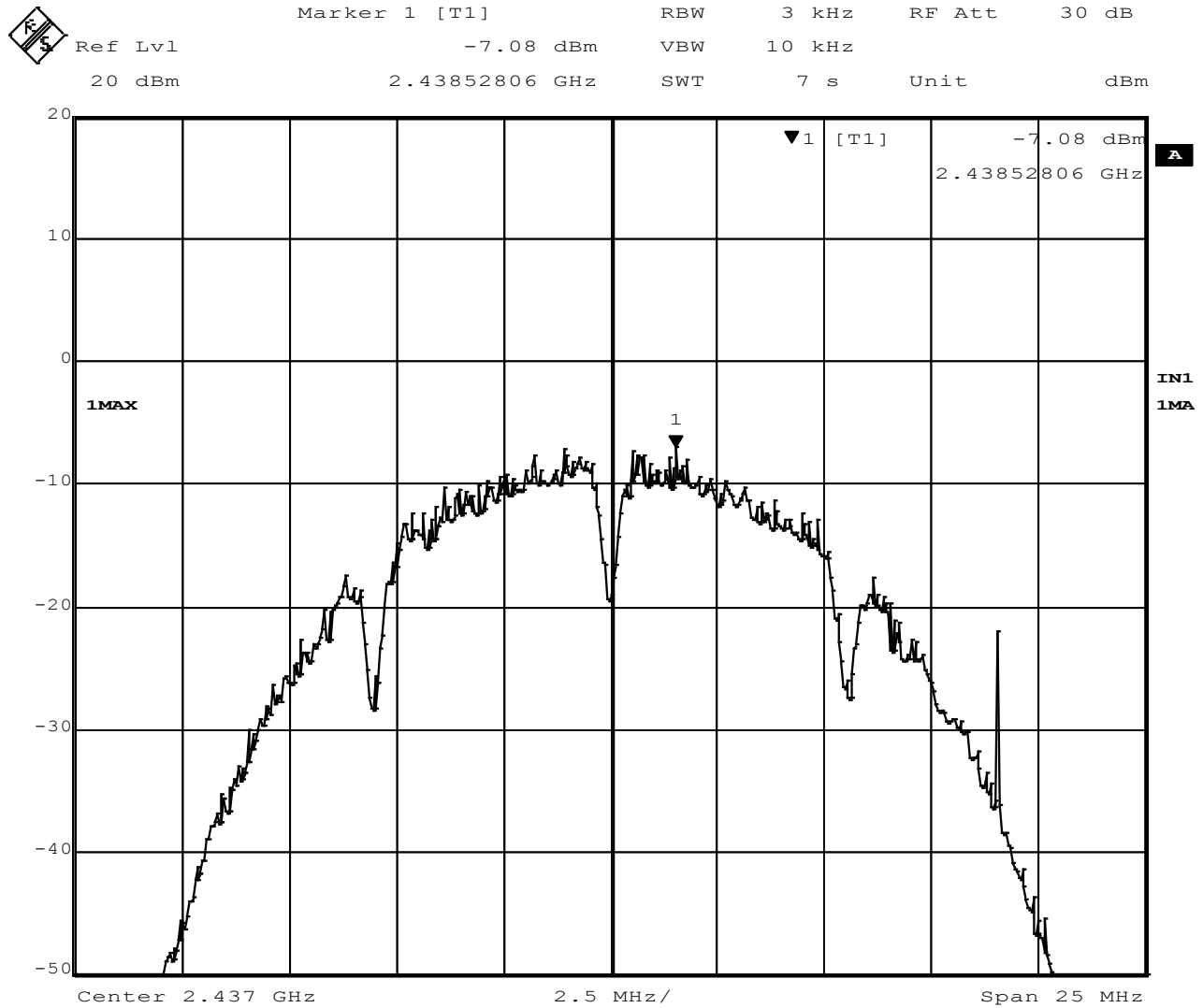


Figure 85 - Power Spectral Density, Mid Channel, 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

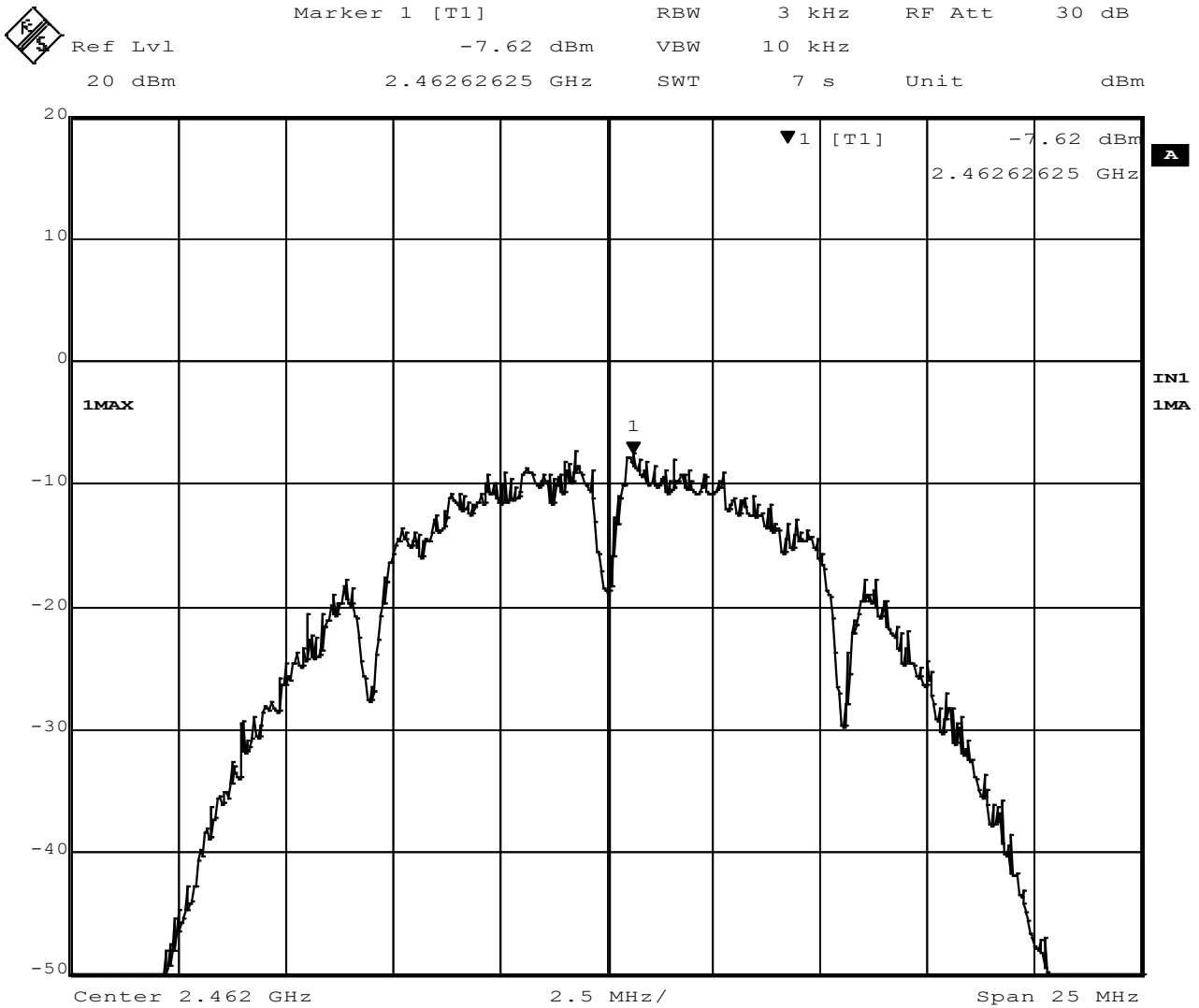


Figure 86 - Power Spectral Density, High Channel, 802.11b

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

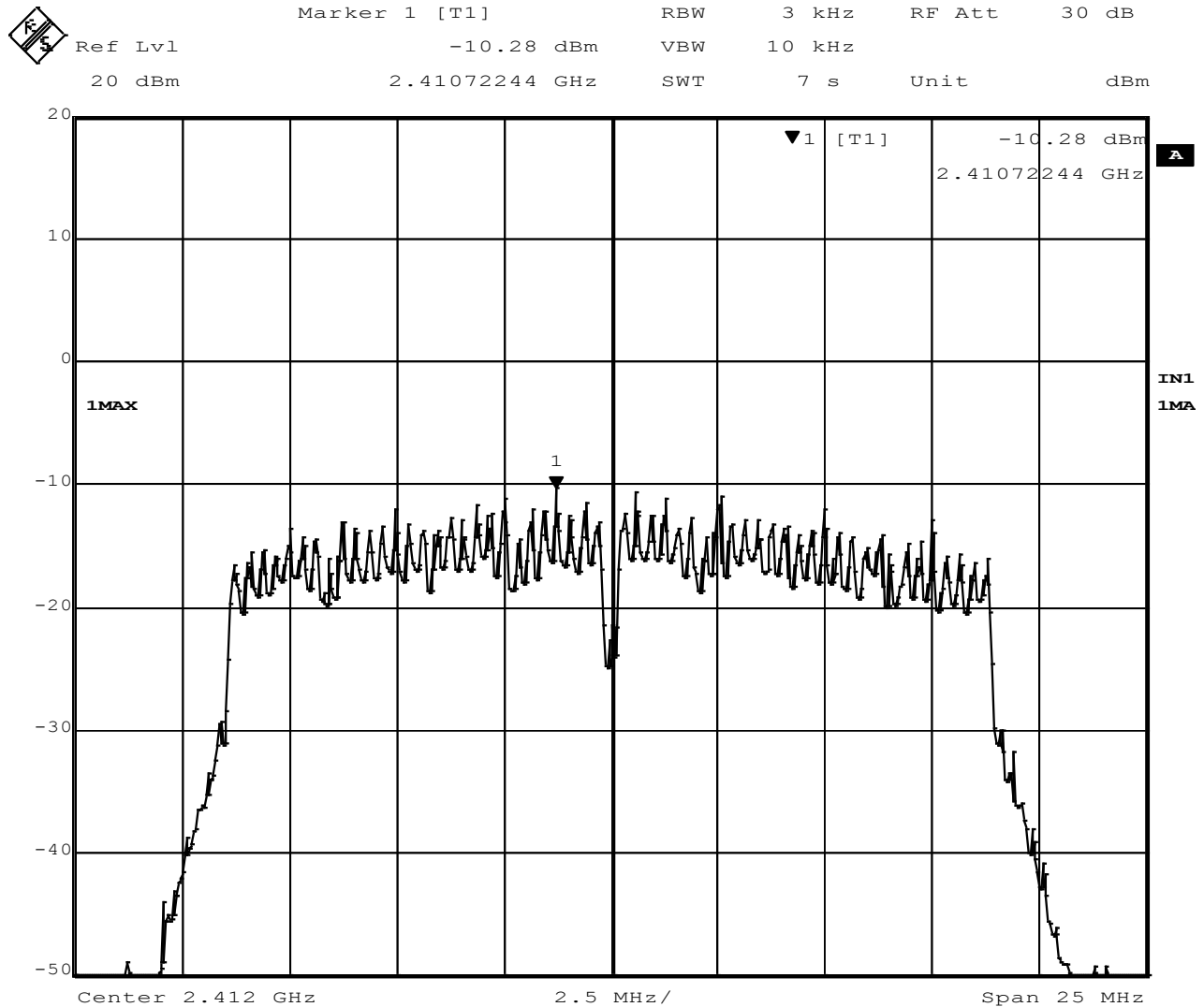


Figure 87 - Power Spectral Density, Low Channel, 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

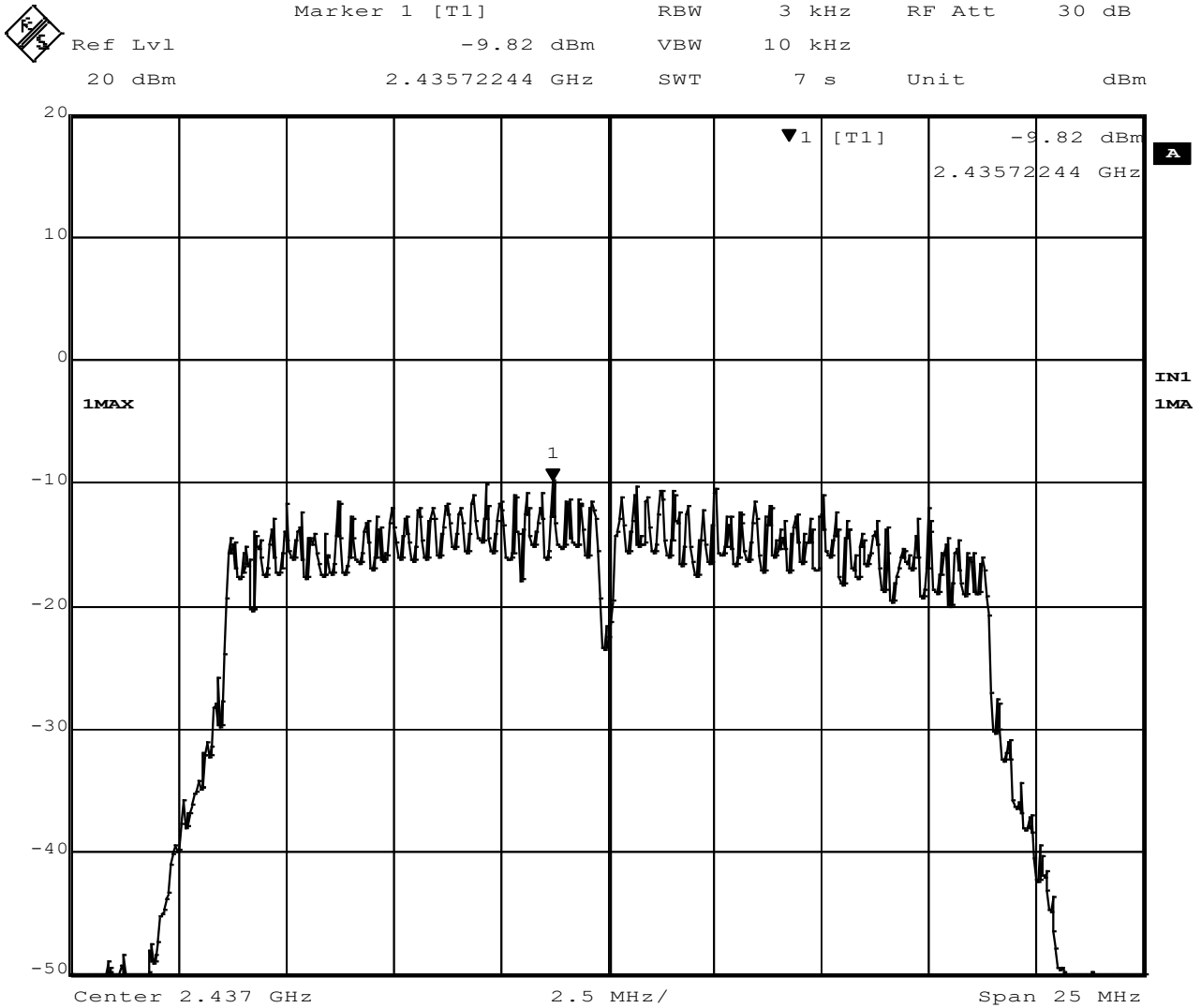


Figure 88 - Power Spectral Density, Mid Channel, 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

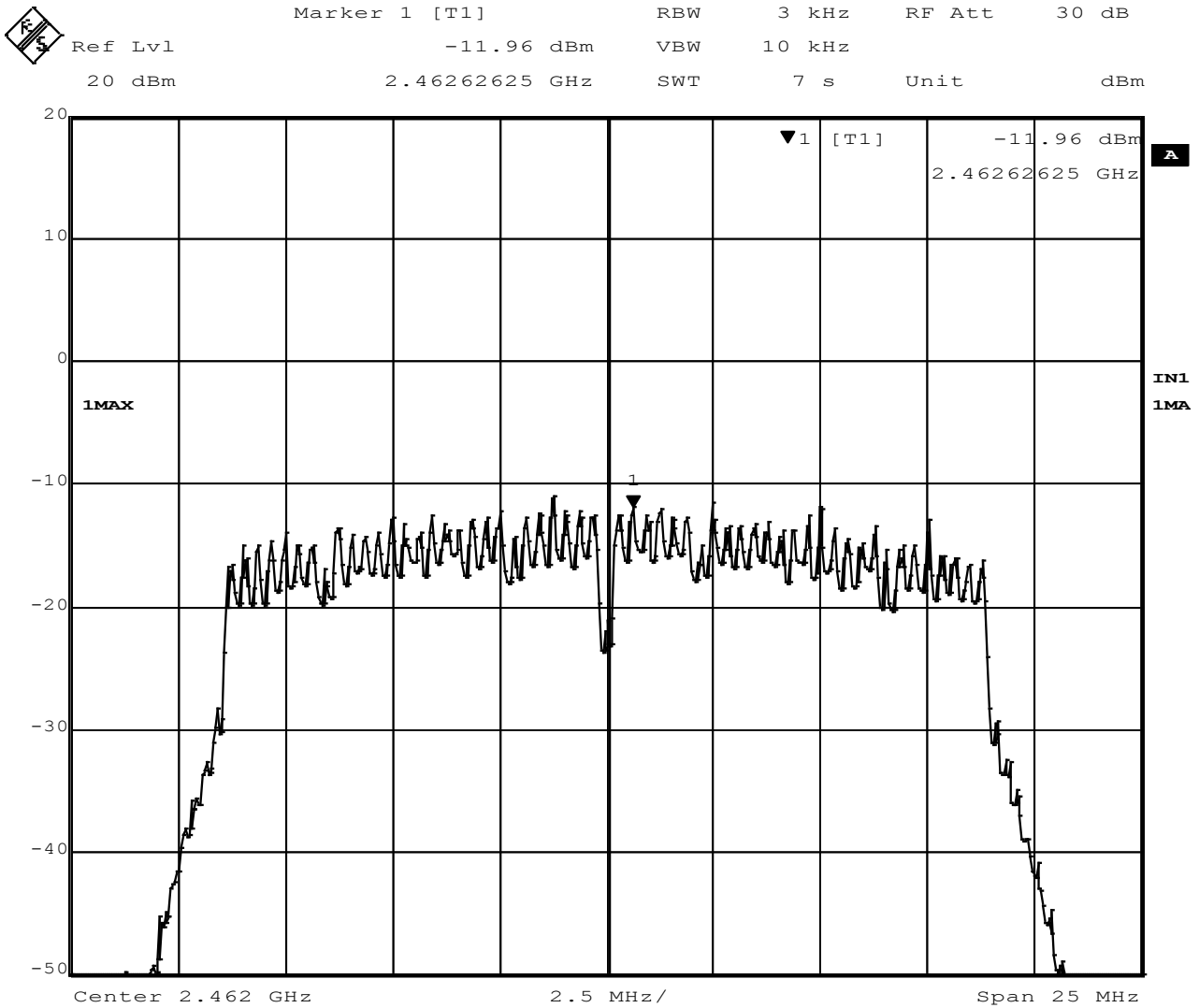


Figure 89 - Power Spectral Density, High Channel, 802.11g

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

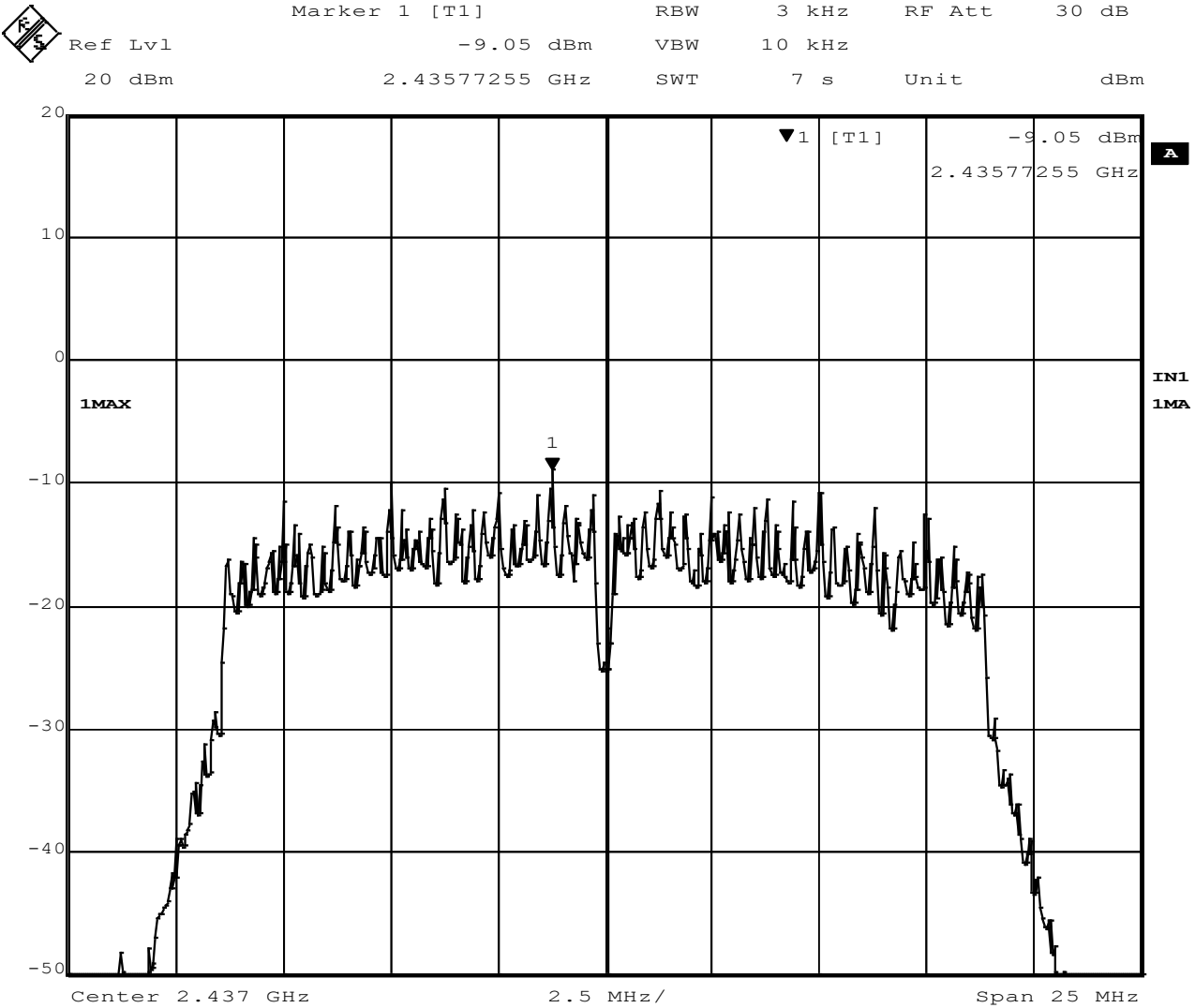


Figure 91 - Power Spectral Density, Mid Channel, 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

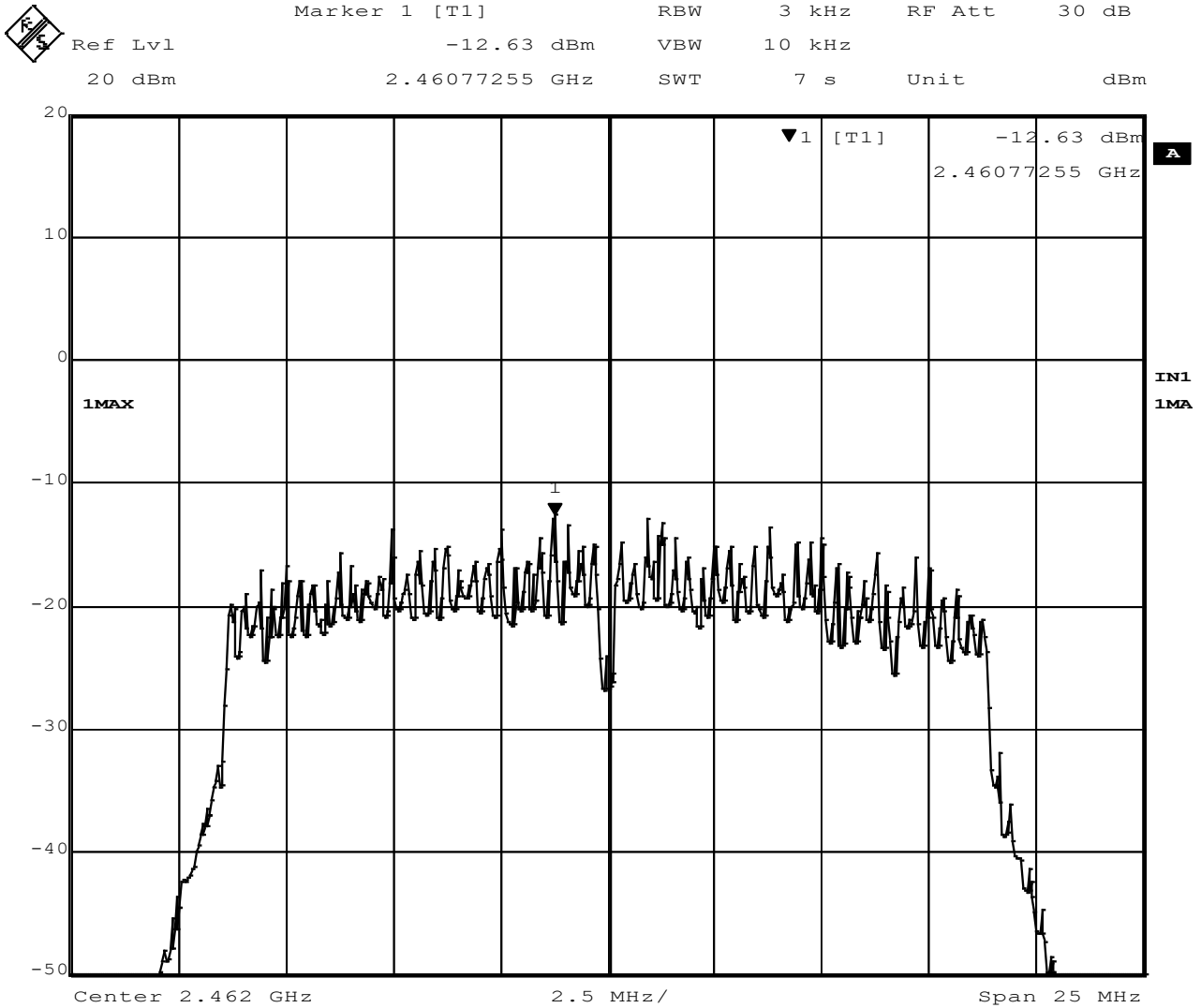


Figure 92 - Power Spectral Density, High Channel, 802.11n

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF - (-CF + AG) + AV$$

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dB μ V is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dB μ V/m.

$$FS = 55 + 12 - (-1.1 + 20) + 0 = 48.1 \text{ dB}\mu\text{V/m}$$

The 48.1 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(48.1 \text{ dB}\mu\text{V/m})/20] = 254.1 \mu\text{V/m}$$

AV is calculated by the taking the $20 \cdot \log(T_{on}/100)$ where T_{on} is the maximum transmission time in any 100ms window.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

$$EIRP (Watts) = [Field Strength (V/m) \times antenna distance (m)]^2 / 30$$

$$Power (watts) = 10^{[Power (dBm)/10]} / 1000$$

$$Voltage (dB\mu V) = Power (dBm) + 107 \text{ (for } 50\Omega \text{ measurement systems)}$$

$$Field Strength (V/m) = 10^{[Field Strength (dB\mu V/m) / 20]} / 10^6$$

$$Gain = 1 \text{ (numeric gain for isotropic radiator)}$$

Conversion from 3m field strength to EIRP (d=3):

$$EIRP = [FS(V/m) \times d^2]/30 = FS [0.3] \quad \text{for } d = 3$$

$$EIRP(dBm) = FS(dB\mu V/m) - 10(\log 10^9) + 10\log[0.3] = FS(dB\mu V/m) - 95.23$$

10log(10^9) is the conversion from micro to milli

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±3.82 dB
Radiated Emissions, 3m	1GHz - 18GHz	±4.44 dB
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB
Antenna port conducted	9 kHz – 25 GHz	±0.50 dB

Values were calculated per CISPR 16-4-2:2011

Expanded uncertainty values are calculated to a confidence level of 95%.

	Report Number:	R20181130-20-03A	Rev	A
	Prepared for:	Garmin		

REPORT END