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FCC/ISED Test Report

Prepared for: **Garmin International Inc.**

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

Product: **A03433**

Test Report No: **R20181107-20-03B**

Approved By:

Nic S. Johnson, NCE
Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: **10 June 2019**

Total Pages: **45**

ilac-MRA A2LA ACCREDITED TESTING LABORATORY CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	15 May 2019	Original – NJohnson Prepared by KVepuri/CFarrington
A	9 June 2019	Calibration table was updated Output power and PSD section were modified to state the measurements were performed radiated. Added conducted values to output power and PSD tables. Removed Note 5 on Page 17 Corrected Table in Section 2.2 Includes NCEE Labs report R20181107-20-03 and its amendment in full -NJ
B	10 June 2019	On p.19, the high channel conducted output power corrected Corrected PSD measurement table. Includes NCEE Labs report R20181107-20-03A and its amendment in full -NJ

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	NA
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	NA

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

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

The Equipment Under Test (EUT) was a wireless device from Garmin. It features 802.11b, 802.11g, 802.11n, GFSK modules and has transmit and receives capabilities

EUT	A03433
EUT Received	20 December 2018
EUT Tested	20 December 2018 - 26 April 2019
Serial No.	NCEETEST1 (assigned)
Operating Band	2400.0 - 2483.5 GHz
Device Type	GFSK
Antenna	Trace Antenna
Power Supply	24 VDC Marine Battery

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

2.2 DESCRIPTION OF TEST MODES

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

Channel	Frequency
Low	2402
Middle	2440
High	2480

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

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 ± 4%
Temperature of 22 ± 3° Celsius

3.2 TEST PERSONNEL

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

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 2020
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

4.0 DETAILED RESULTS

4.1 DUTY CYCLE

Test Method: NA

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 unrestricted 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 affect 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 (dBuV/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.

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 form 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). All final measurements were performed with the EUT transmitting continuously in these modes.

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:

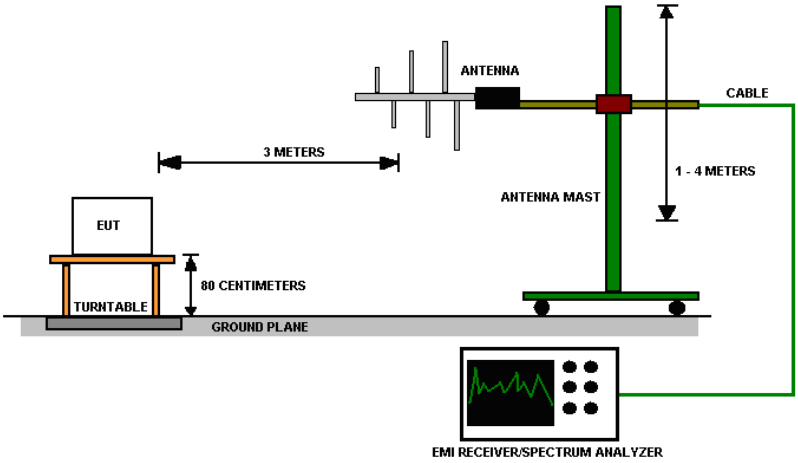

Figure 1 - Radiated Emissions Test Setup

EUT operating conditions
The EUT was powered by a 24V battery 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 GFSK.

Test results:

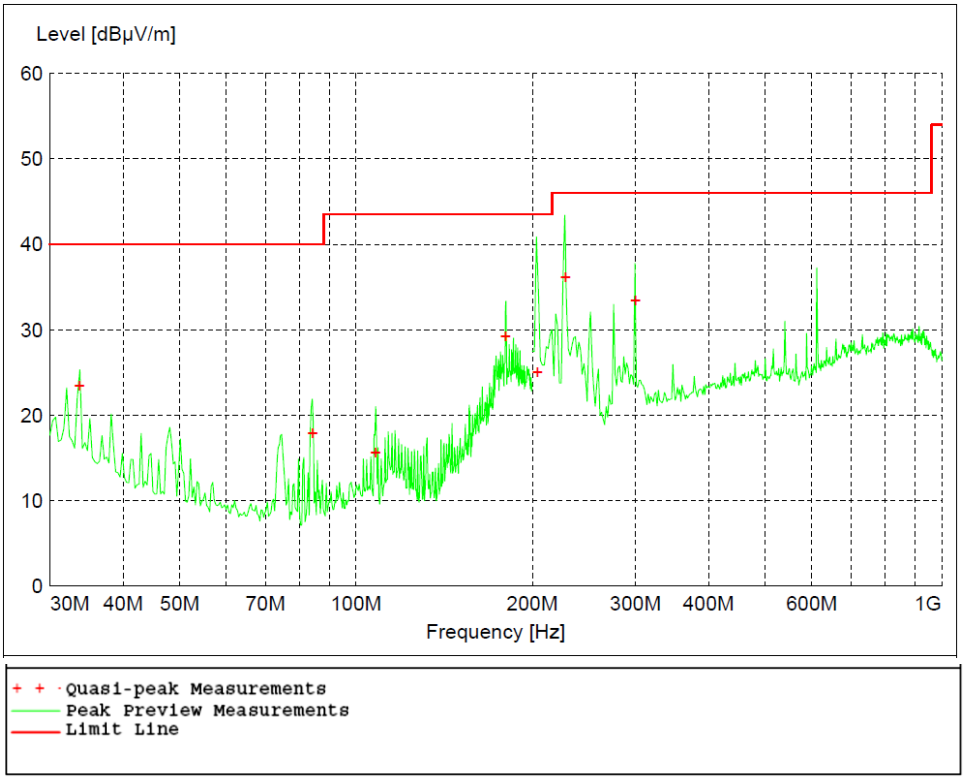

Figure 2 - Radiated Emissions Plot, Receive

Table 1 - Radiated Emissions Quasi-peak and Peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
33.720000	23.52	40.00	16.50	98	24	VERT
84.360000	17.93	40.00	22.10	223	180	HORI
108.000000	15.64	43.50	27.90	101	122	VERT
180.000000	29.26	43.50	14.30	186	163	HORI
204.060000	25.11	43.50	18.40	100	21	VERT
228.000000	36.19	46.00	9.80	400	80	VERT
300.060000	33.43	46.00	12.60	100	189	HORI

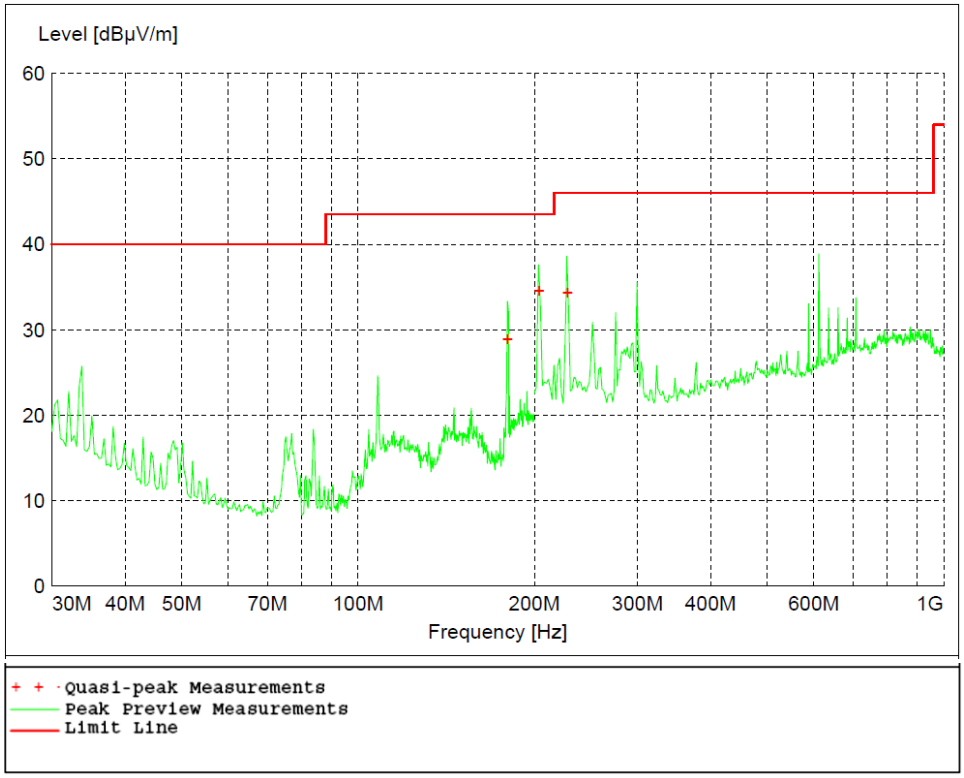

Figure 3 - Radiated Emissions Plot, Low Channel

Table 2 - Radiated Emissions Quasi-peak Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
180.000000	28.89	43.50	14.60	99	116	VERT
204.000000	34.56	43.50	9.00	156	165	HORI
228.000000	34.41	46.00	11.60	102	111	VERT

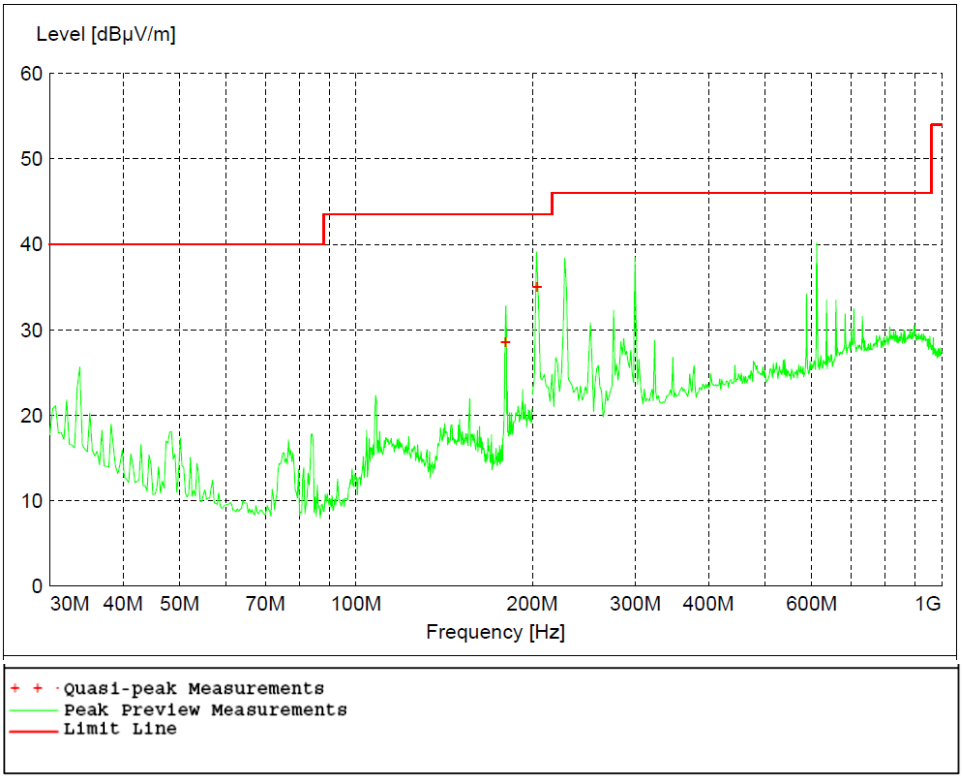

Figure 4 - Radiated Emissions Plot, Mid Channel

Table 3 - Radiated Emissions Quasi-peak Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
180.000000	28.60	43.50	14.90	99	121	VERT
204.000000	35.03	43.50	8.50	100	81	VERT

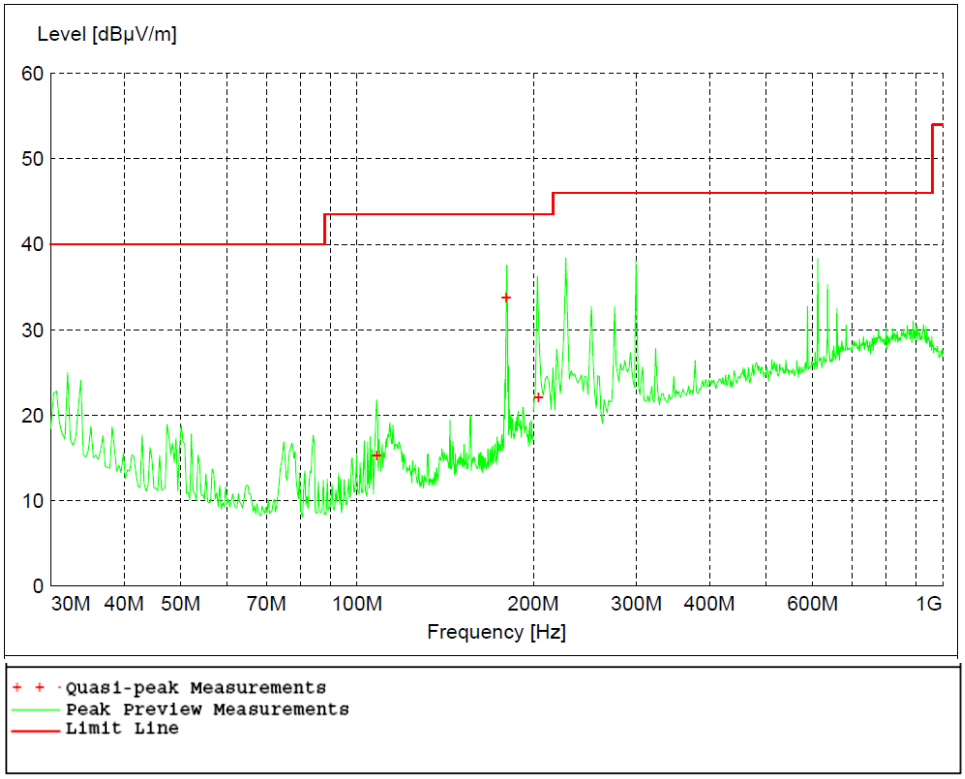

Figure 5 - Radiated Emissions Plot, High Channel

Table 4 - Radiated Emissions Quasi-peak Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
108.120000	15.27	43.50	28.30	109	107	VERT
179.940000	33.77	43.50	9.80	189	104	HORI
204.060000	22.08	43.50	21.40	100	47	VERT

Table 5 - Radiated Emissions Peak Detector Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2402.000000	101.21	N/A	N/A	163	264	HORI
4804.000000	60.62	74.00	13.38	177	180	HORI

Table 6 - Radiated Emissions Average Detector Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2402.000000	100.83	N/A	N/A	163	264	HORI
4804.000000	51.85	54.00	2.20	177	180	HORI

Table 7 - Radiated Emissions Peak Detector Measurements, Middle Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2442.000000	102.12	N/A	N/A	211	45	HORI
4876.000000	56.84	74.00	17.16	174	173	HORI

Table 8 - Radiated Emissions Average Detector Measurements, Middle Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2442.000000	101.76	N/A	N/A	211	45	HORI
4876.000000	49.35	54.00	4.60	174	173	HORI

Table 9 - Radiated Emissions Peak Detector Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2480.000000	101.57	N/A	N/A	206	20	HORI
4960.600000	51.99	74.00	22.01	100	284	HORI

Table 10 - Radiated Emissions Average Detector Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2480.000000	101.24	N/A	N/A	206	20	HORI
4960.600000	44.03	54.00	10.00	100	284	HORI

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.

4.3 PEAK OUTPUT POWER

Test Method: ANSI C63.10:
1. Section(s) 11.9.1.1

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

Test procedures:
All measurements were taken at a distance of 3m from the EUT. The EUT was maximized in all 3 orthogonal positions.10 MHz RBW and 10 MHz VBW was used. 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:

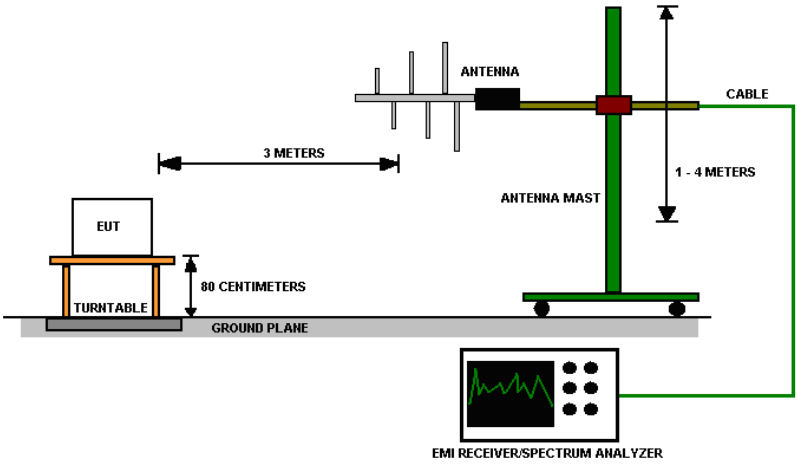

Figure 6 – Peak Output Power Measurements Test Setup

EUT operating conditions:
The EUT was powered by a 24V battery 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

Peak Output Power

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK OUTPUT POWER EIRP (dBm) MU = ±1.1 dB	PEAK OUTPUT POWER CONDUCTED* (dBm) MU = ±1.1 dB	Method	RESULT
Low	2402	6.61	0.31	Radiated	PASS
Middle	2440	7.08	0.78	Radiated	PASS
High	2480	6.63	0.33	Radiated	PASS

*Conducted power calculated from EIRP measurement with 6.3 dB subtracted to account for peak antenna gain

Sample EIRP measurement can be found in Appendix A. The plots reflect uncorrected value.

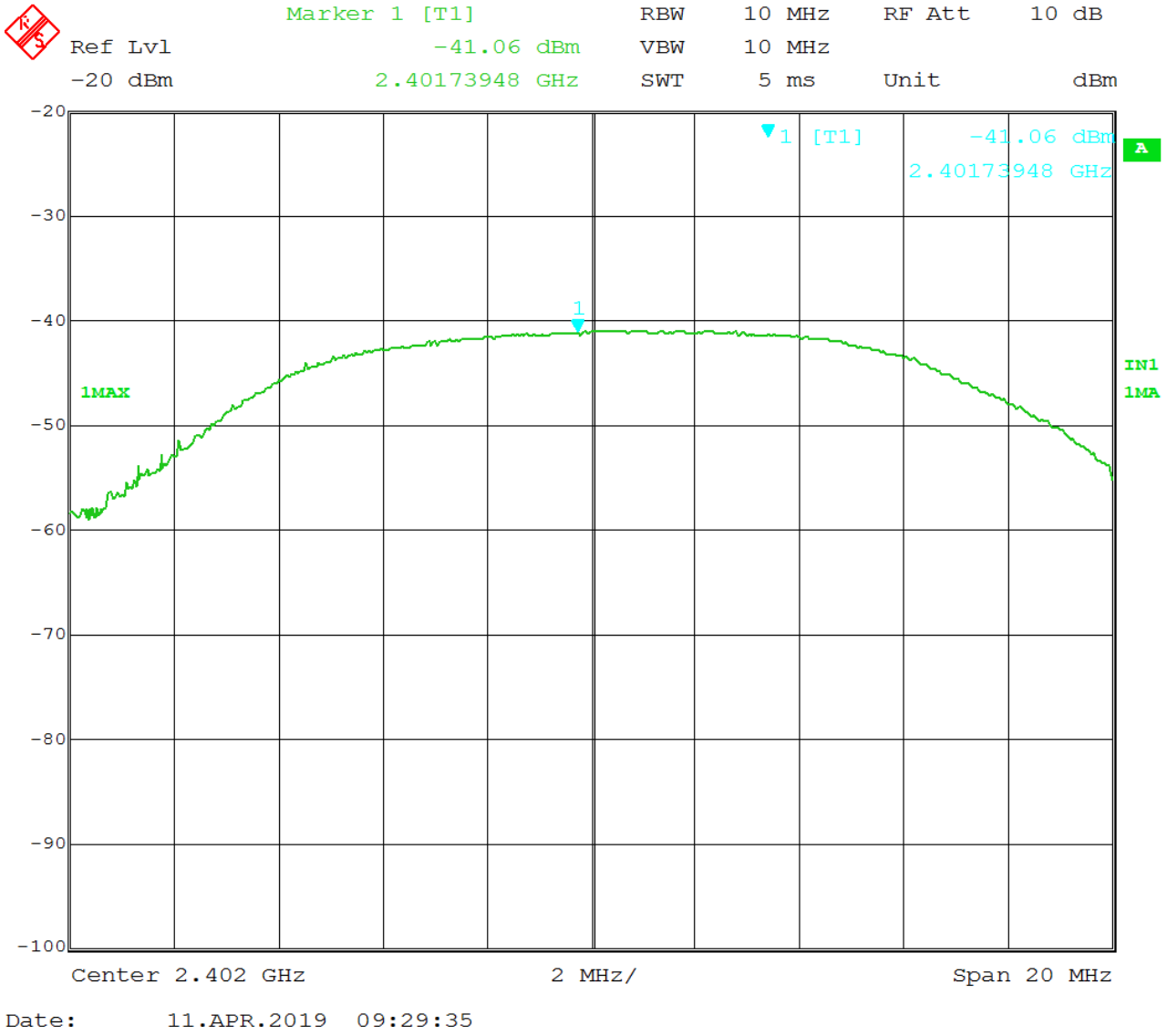

Figure 7 – Peak Output Power, Low Channel, GFSK

Maximum power = -41.06 dBm + 107 + CL + AF - 95.23 = 6.61 dBm*

CL = cable loss = 7.60 dB
AF = antenna factor = 28.30 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance

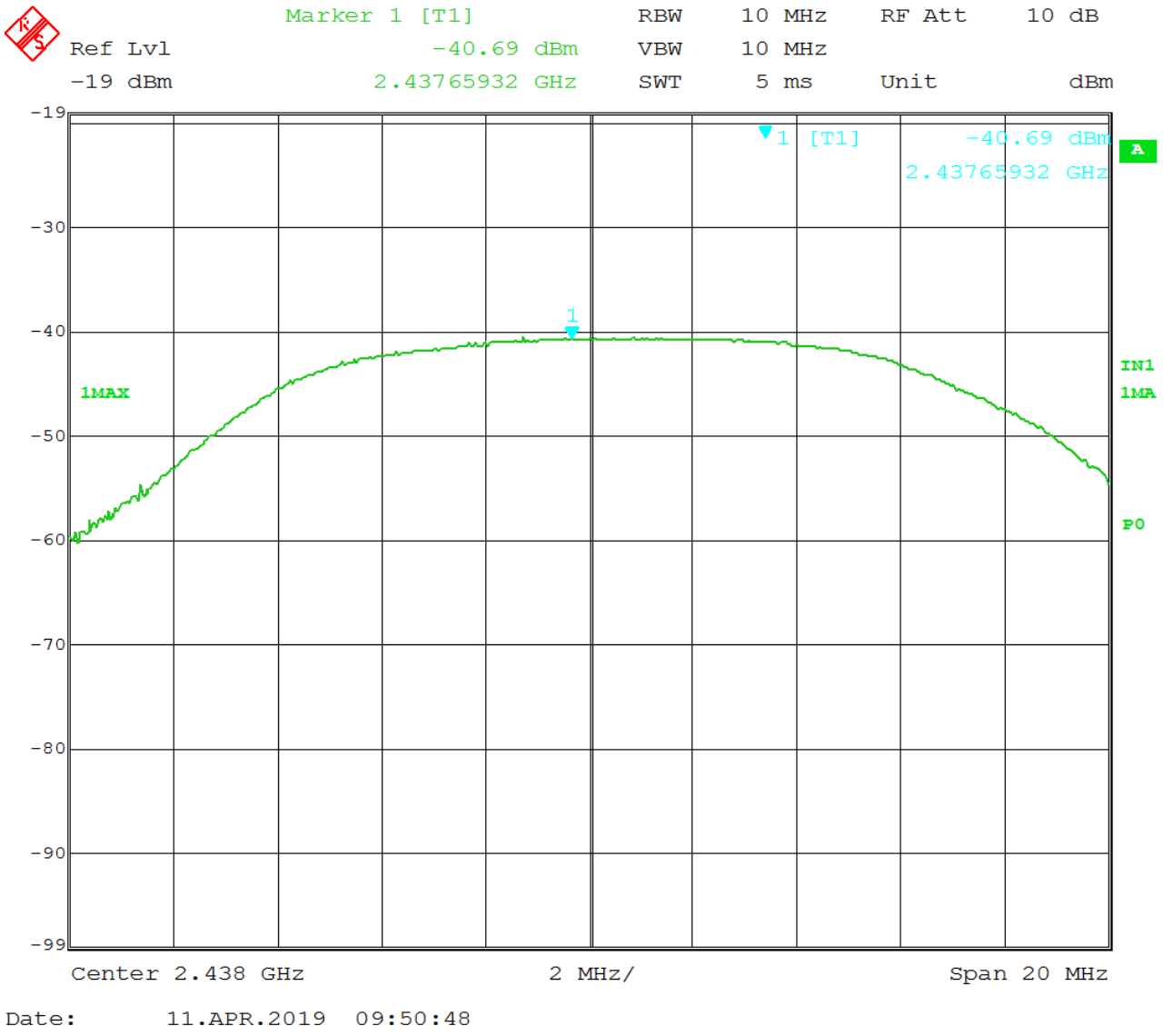

Figure 8 – Peak Output Power, Mid Channel, GFSK

Maximum power = -40.69 dBm + 107 + CL + AF - 95.23 = 7.08 dBm*

CL = cable loss = 7.70 dB
AF = antenna factor = 28.30 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance

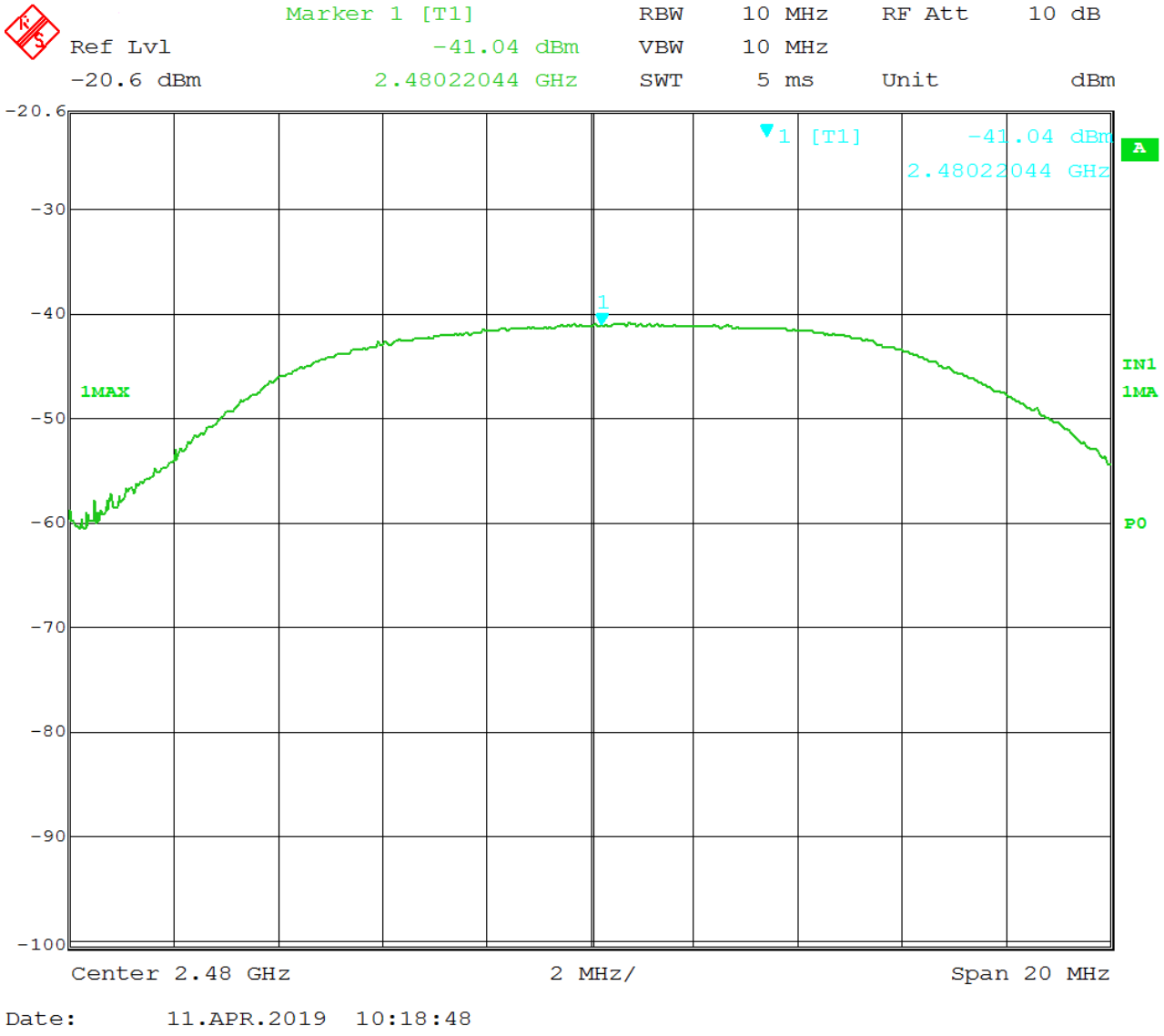

Figure 9 – Peak Output Power, High Channel, GFSK

Maximum power = -41.04 dBm + 107 + CL + AF - 95.23 = 6.63 dBm*

CL = cable loss = 7.70 dB
AF = antenna factor = 28.20 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance

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:
All measurements were taken at a distance of 3m from the EUT. 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.

Deviations from test standard:
No deviation

Test setup:
See Section 4.3

EUT operating conditions:
The EUT was powered by a 24V battery 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)	99% Occupied BW (MHz)
Low	2402	1.13
Middle	2440	1.10
High	2480	1.11

6dB Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	6 dB BW (kHz)
Low	2402	667.33
Middle	2440	739.48
High	2480	751.50

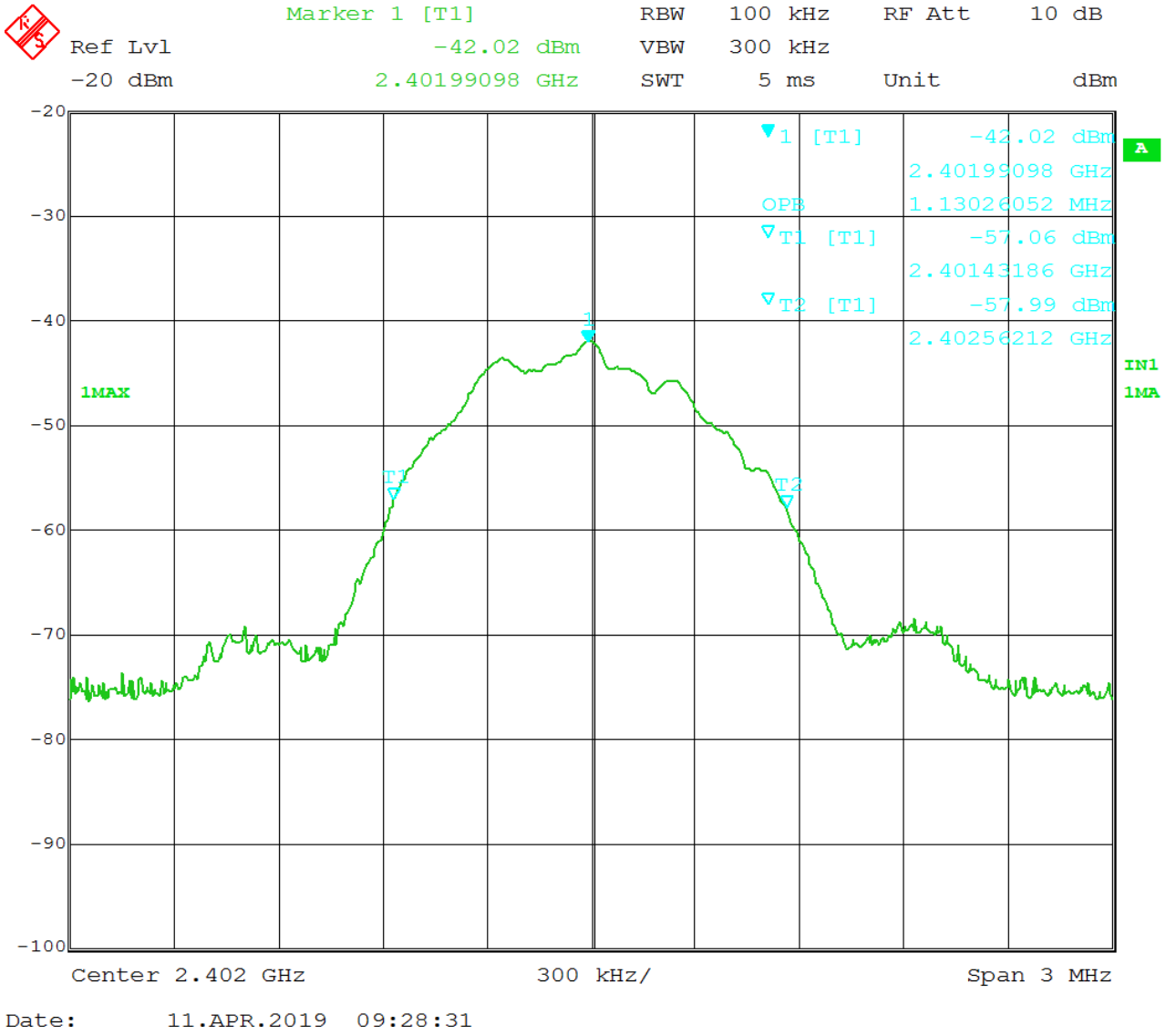

Figure 10 - 99% Occupied Bandwidth, Low Channel, GFSK

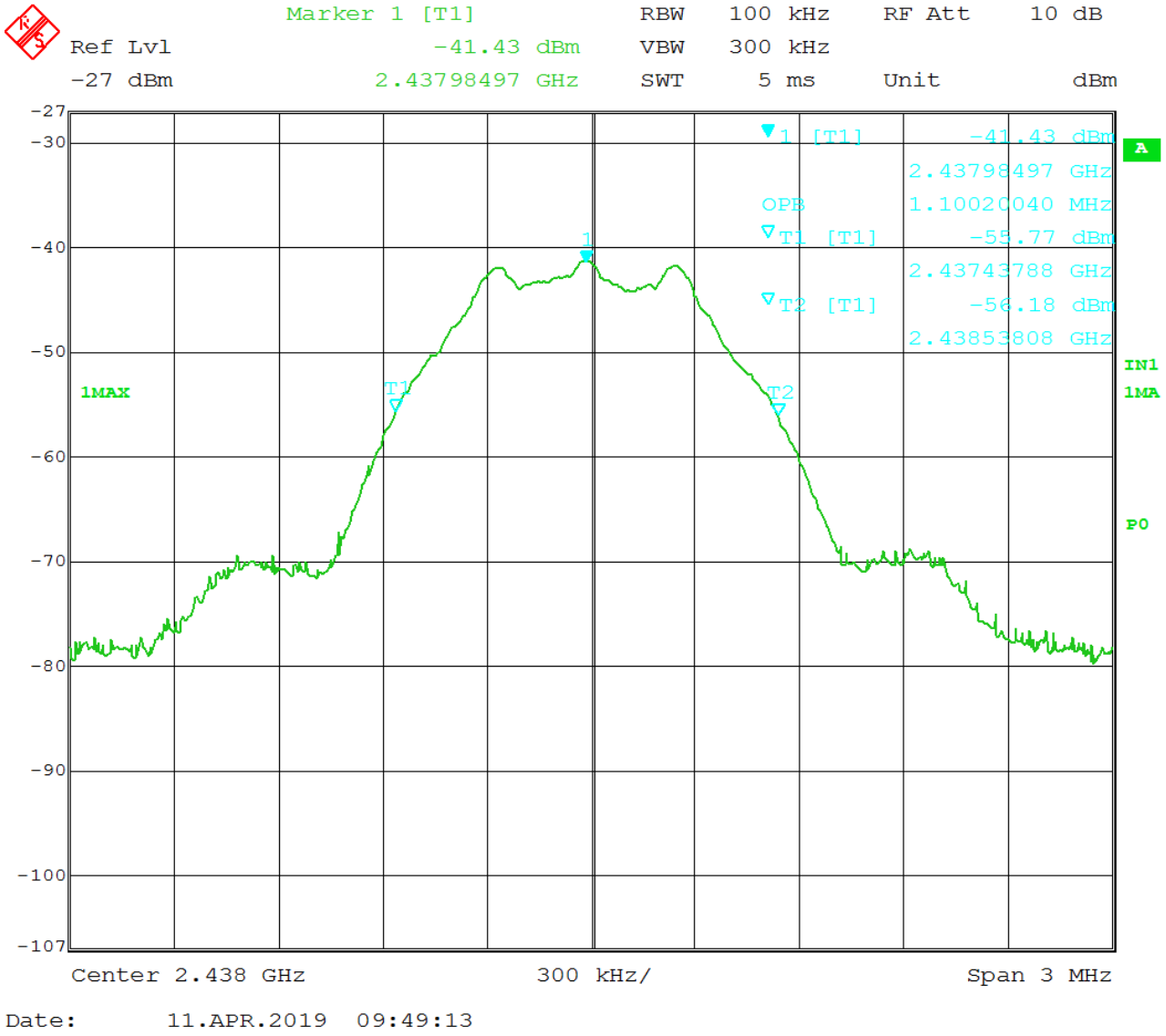

Figure 11 - 99% Occupied Bandwidth, Mid Channel, GFSK

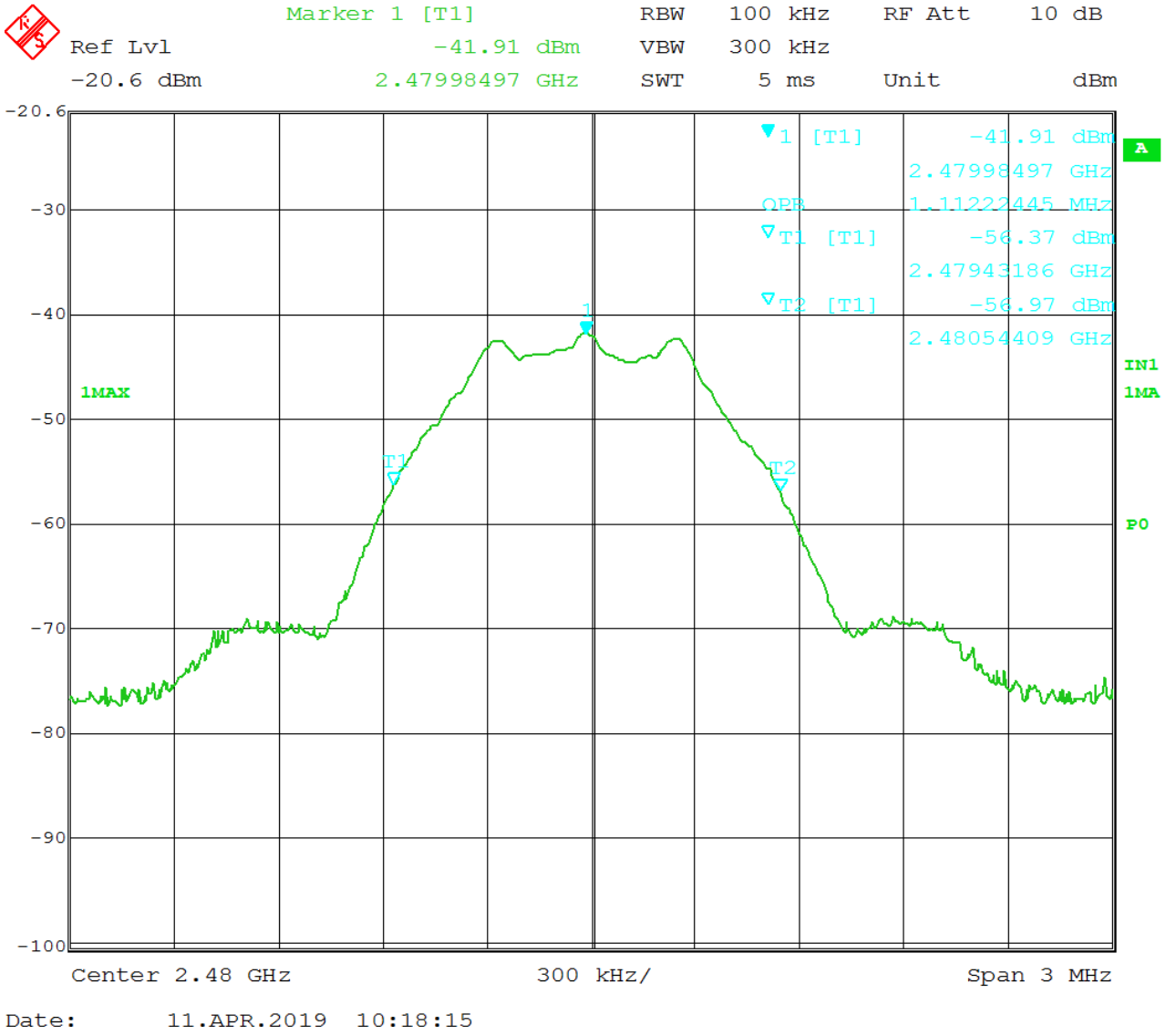

Figure 12 - 99% Occupied Bandwidth, High Channel, GFSK

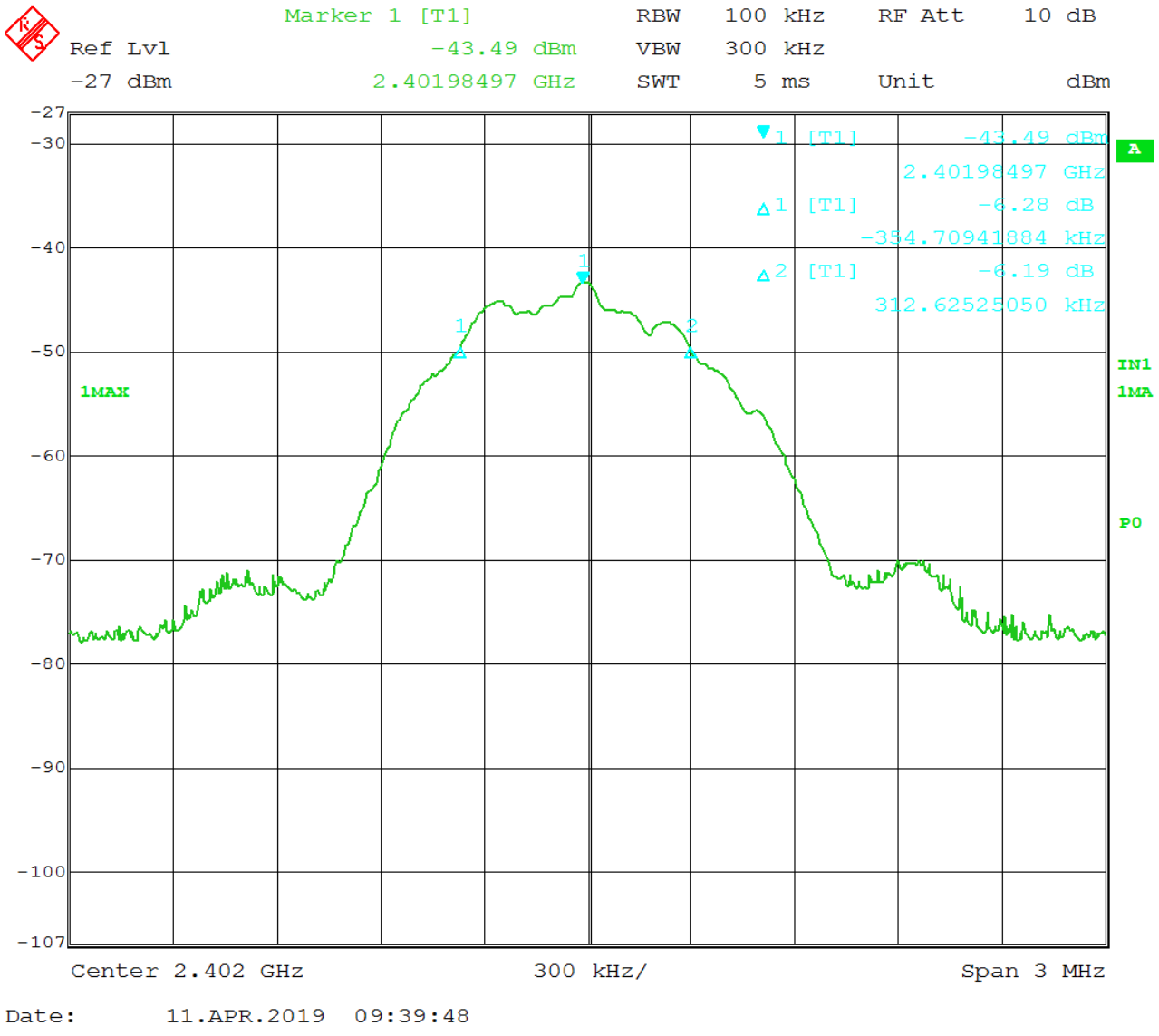

Figure 13 - 6dB Bandwidth, Low Channel, GFSK

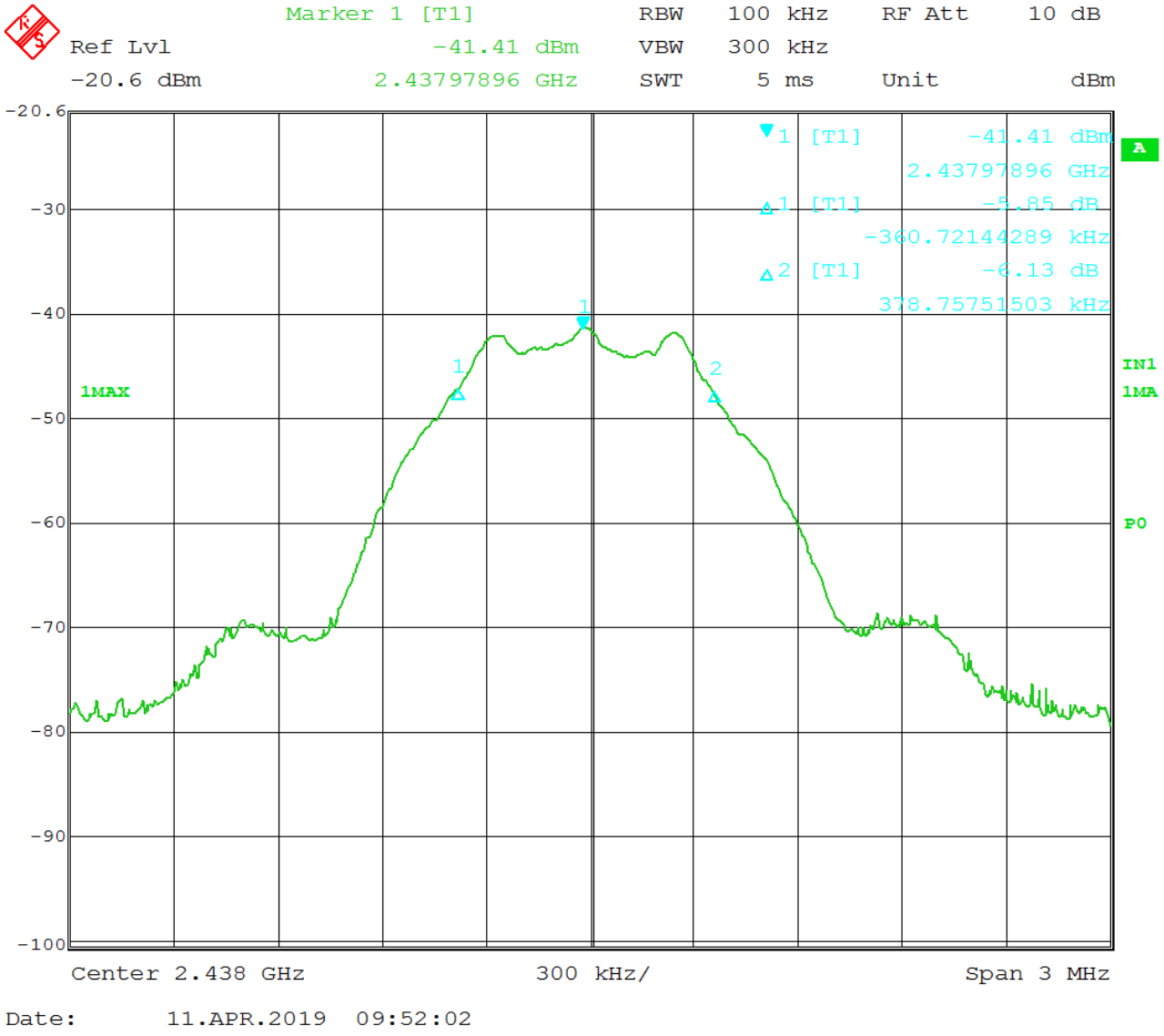

Figure 14 - 6dB Bandwidth, Mid Channel, GFSK

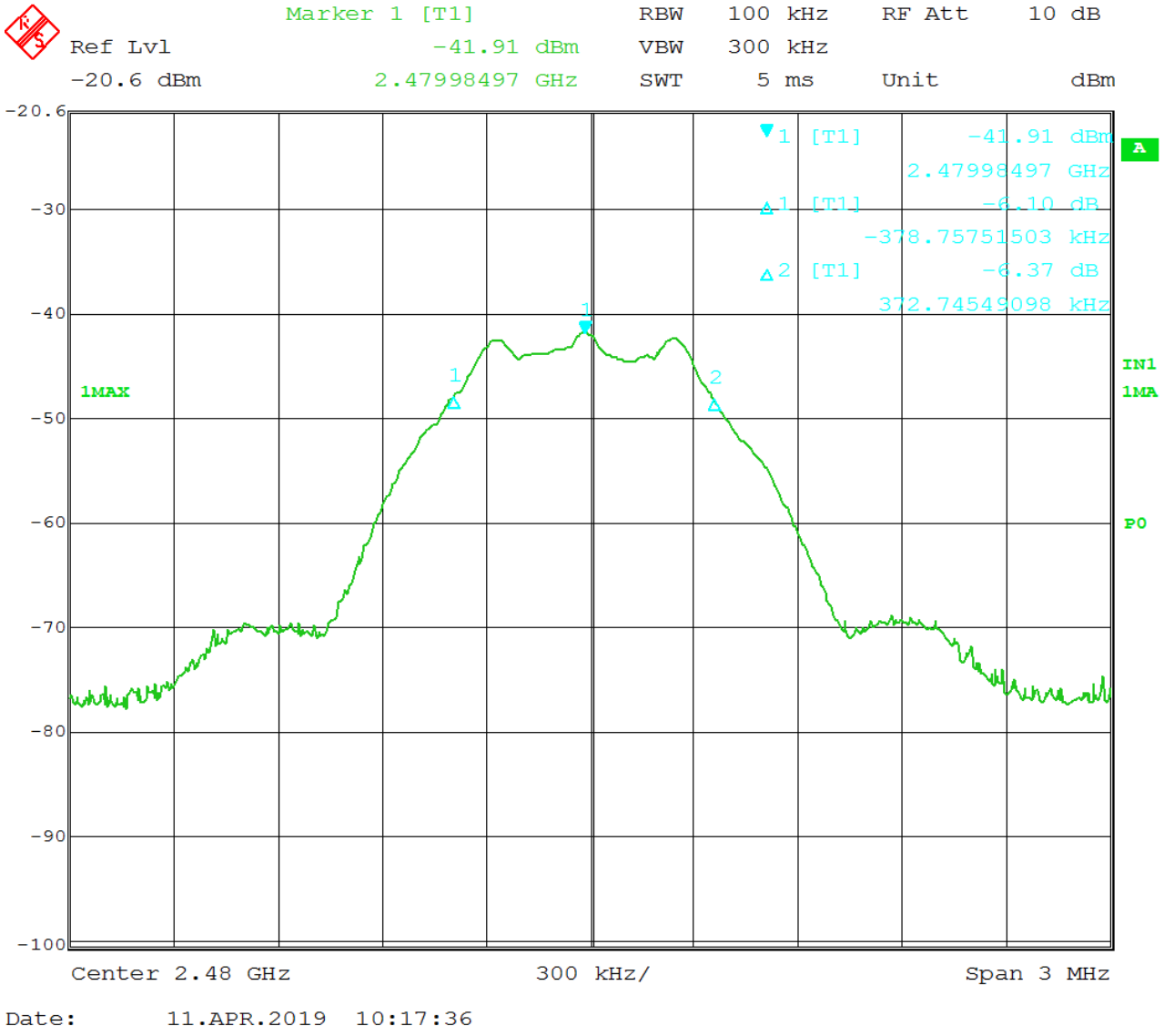

Figure 15 - 6dB Bandwidth, High Channel, GFSK

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 a 24V battery 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:

CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level dBm	Relative Fundamental dBm	Delta (dB)	Min Delta (dB)	Result
Low, Continuous (restricted)	GFSK	2390	-98.44	-42.15	56.29	47.21	PASS
High, Continuous (restricted)	GFSK	2483.5	-96.44	-41.95	54.49	47.57	PASS
Low, Continuous (unrestricted)	GFSK	2400	-73.43	-42.15	31.28	20.00	PASS
High, Continuous (unrestricted)	GFSK	2483.5	-75.92	-41.95	33.97	20.00	PASS

*Minimum delta = [highest fundamental peak field strength from Section 4.2] – [Part 15.209 radiated emissions limit.]

From Section 4.2

Fundamental peak field strength at Low Channel GFSK = 101.21 dBµV/m
Fundamental peak field strength at High Channel GFSK = 101.57 dBµV/m

Low Channel minimum delta GFSK = 101.21 – 54.0 dBµV/m = 47.21 dBc
High Channel minimum delta GFSK = 101.57 – 54.0 dBµV/m = 47.57 dBc

FCC Part 15.249 requires the attenuation of all emissions outside of the specified band to be at least 50 dB or below the 15.209 limits, whichever is the lesser. In this case, the 15.209 limits were the lesser and used to show compliance.

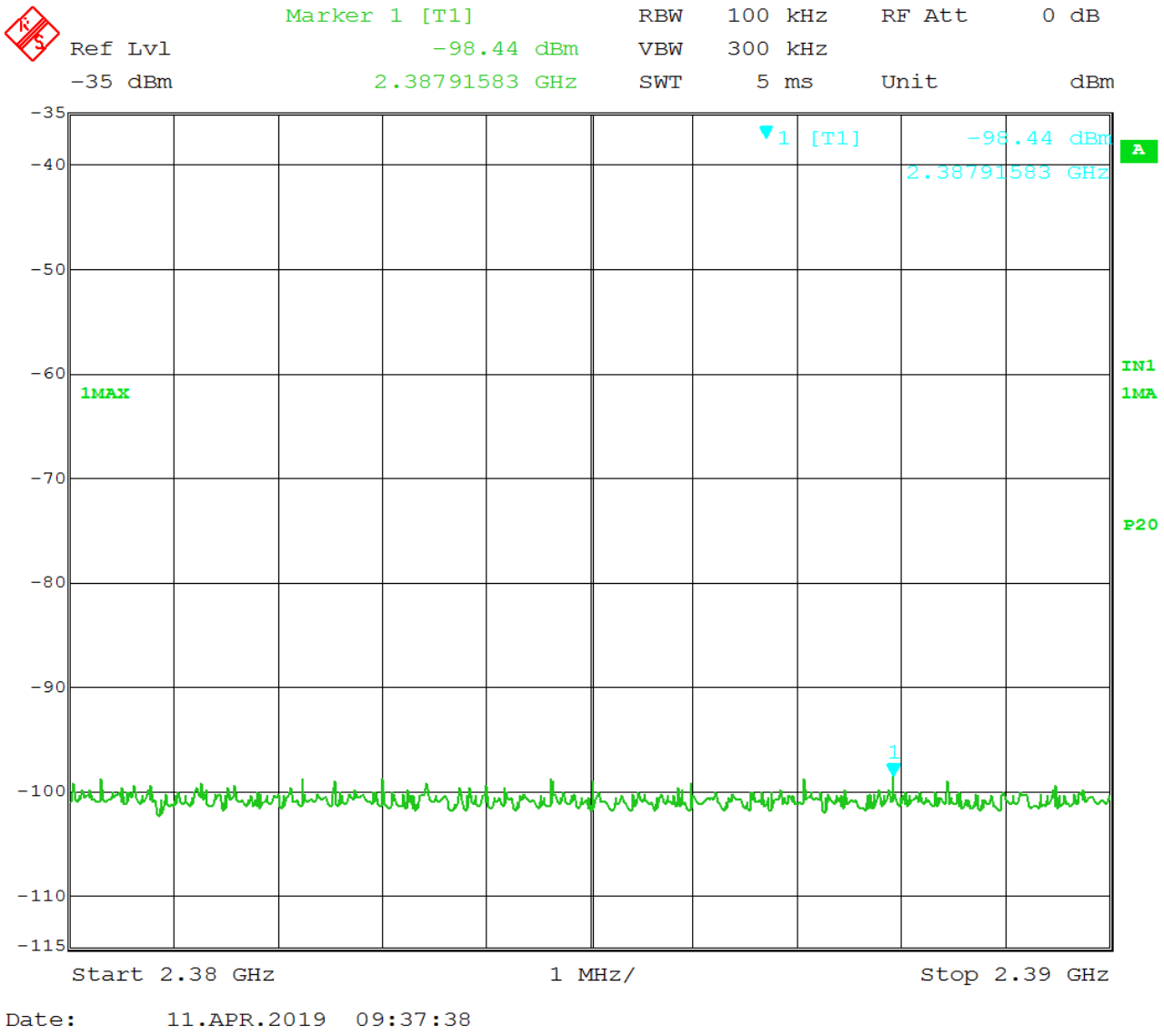

Figure 16 - Band-edge Measurement, Low Channel, Restricted Frequency, Peak

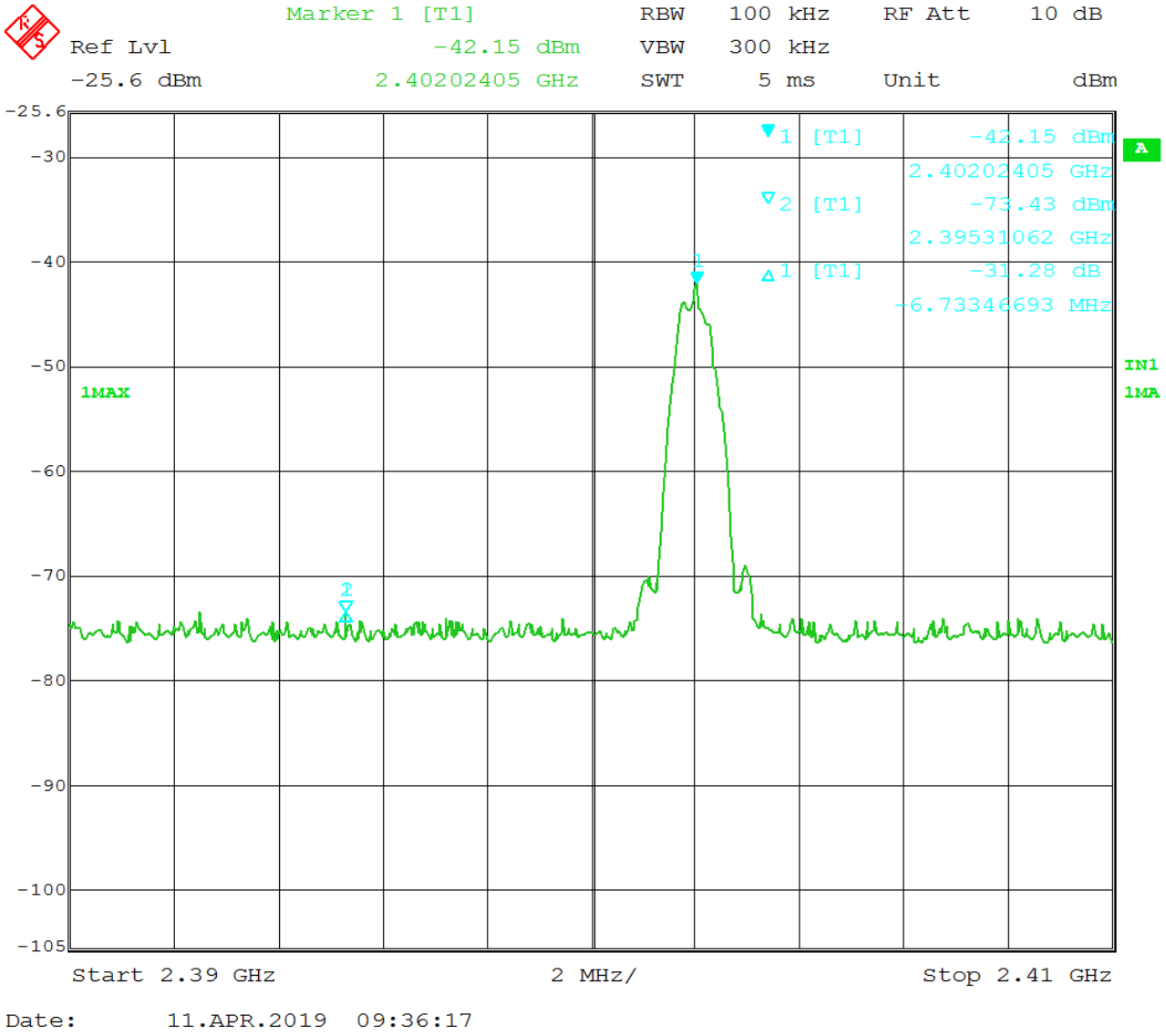

Figure 17 - Band-edge Measurement, Low Channel, Fundamental, Peak

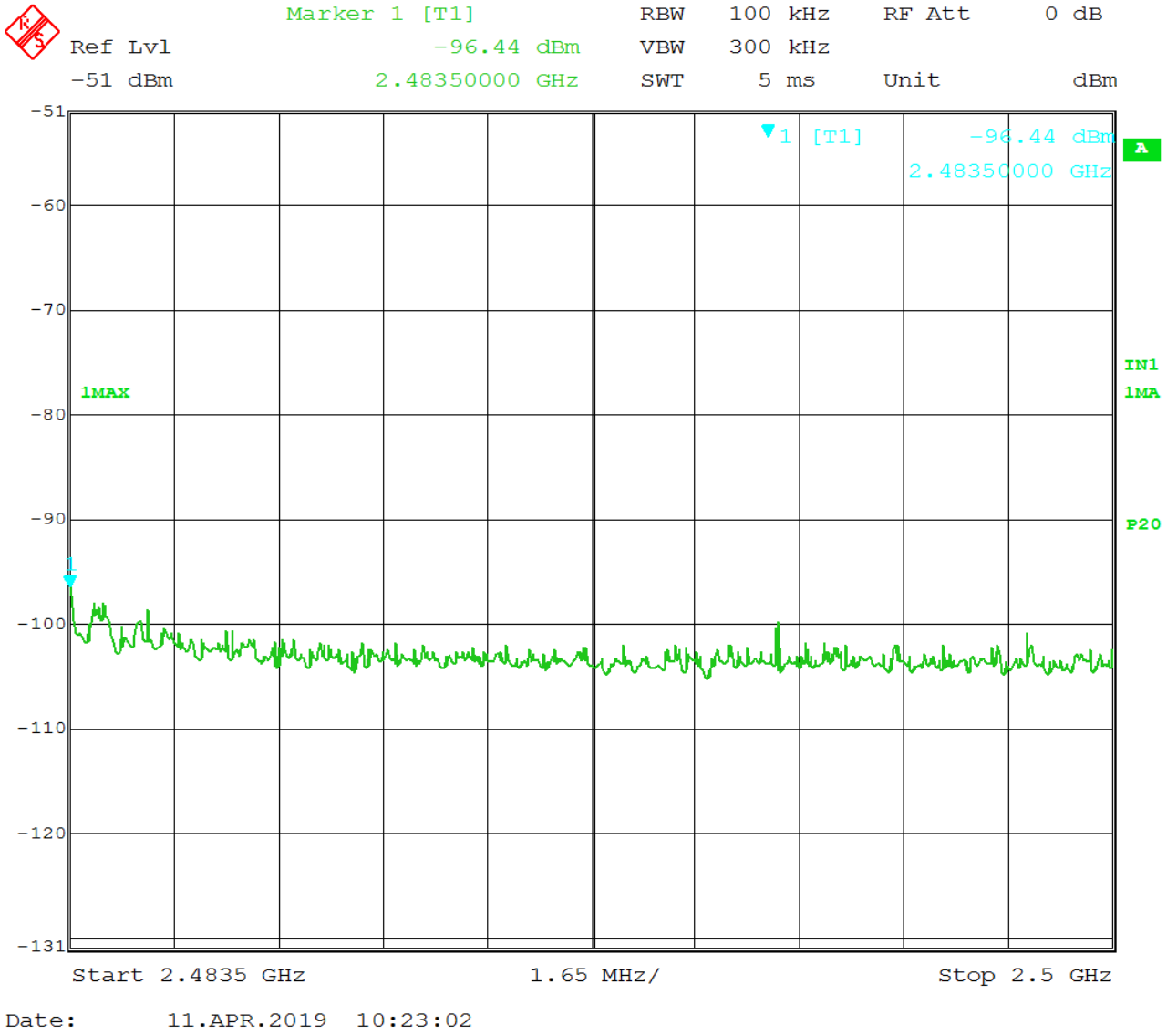

Figure 18 - Band-edge Measurement, High Channel, Restricted Frequency, Peak

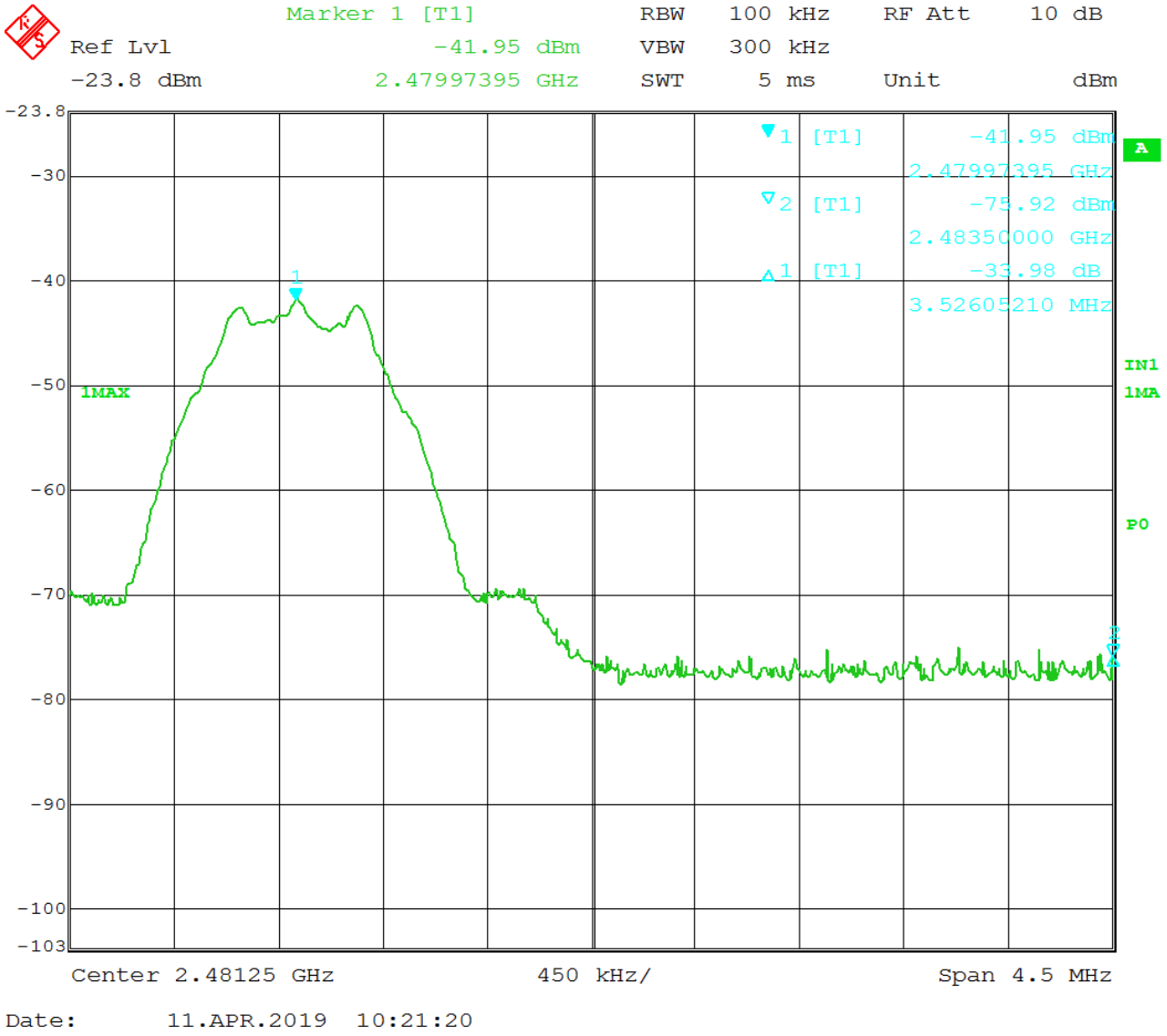

Figure 19 - Band-edge Measurement, High Channel, Fundamental, Peak

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. All measurements were taken at a distance of 3m from the EUT. The EUT was maximized in all 3 orthogonal positions.

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 test setup was identical to that in Section 4.3.

EUT operating conditions:
The EUT was powered by a 24V battery 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:
See Section 4.3

Power Spectral Density

CHANNEL	CHANNEL FREQUENCY (MHz)	EIRP PEAK PSD (dBm)	Conducted* PEAK PSD (dBm)	Limit (dBm)	RESULT
Low	2402	-1.16	-7.46	8.00	PASS
Middle	2440	-8.72	-15.02	8.00	PASS
High	2480	-9.45	-15.75	8.00	PASS

*Conducted power calculated from EIRP measurement with 6.3 dB subtracted to account for peak antenna gain

** Sample EIRP measurement can be found in Appendix A. The plots reflect uncorrected value.

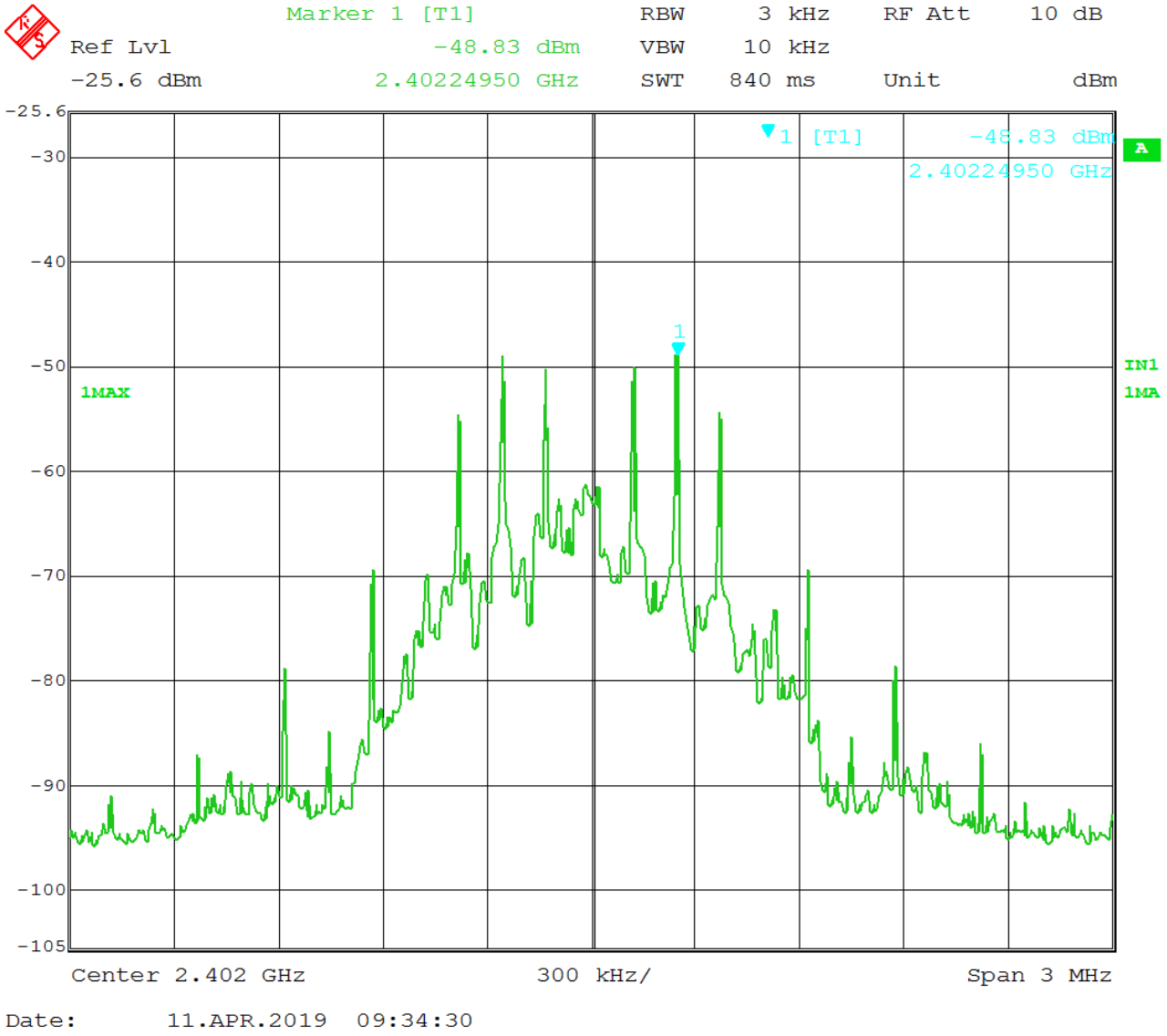

Figure 20 - Power Spectral Density, Low Channel

PSD = -48.83 dBm + 107 + CL + AF - 95.23 = -1.16 dBm

CL = cable loss = 7.60 dB
AF = antenna factor = 28.30 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance

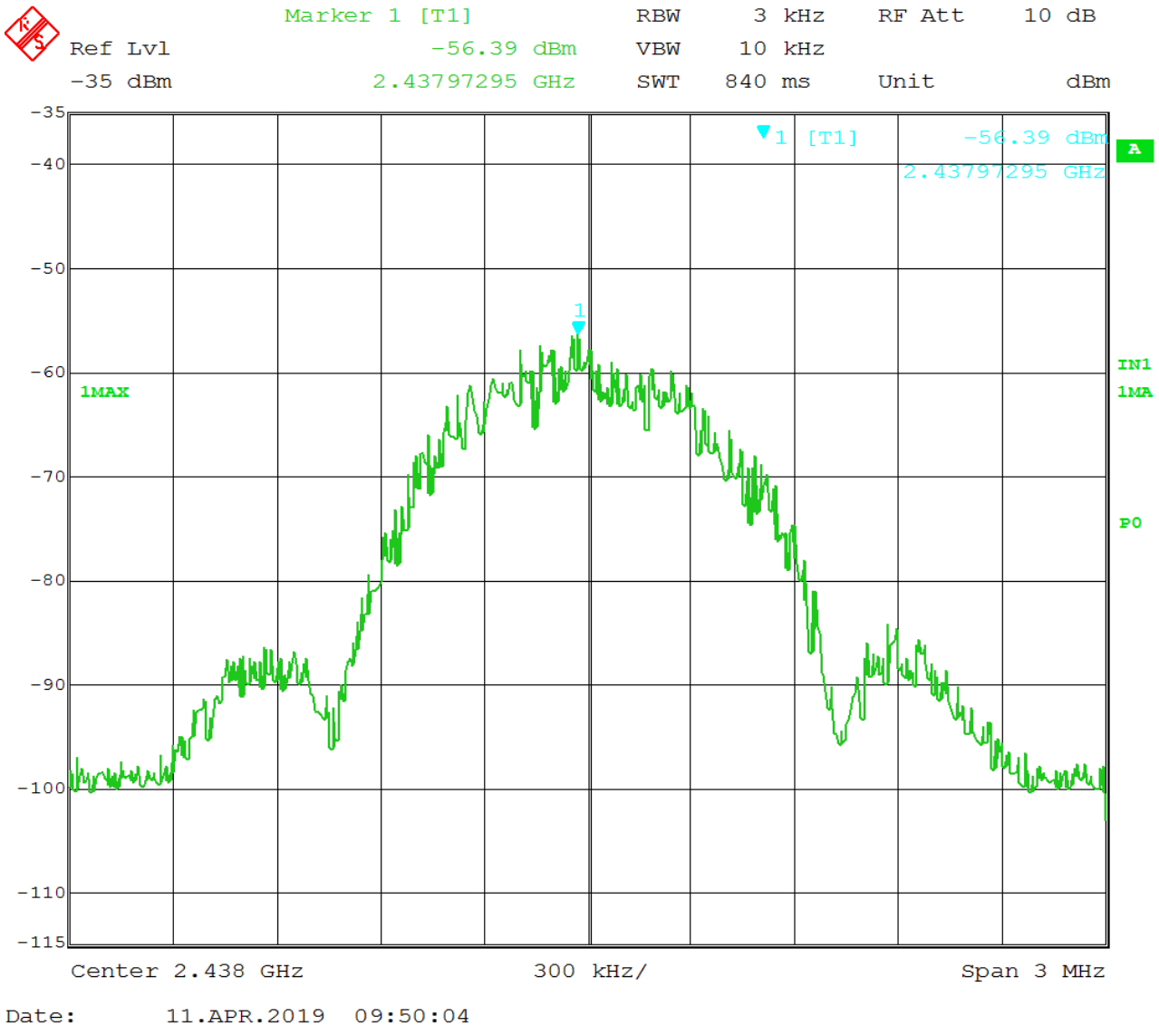

Figure 21 - Power Spectral Density, Mid Channel

PSD = -56.39 dBm + 107 + CL + AF - 95.23 = -8.72 dBm

CL = cable loss = 7.60 dB
AF = antenna factor = 28.30 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance

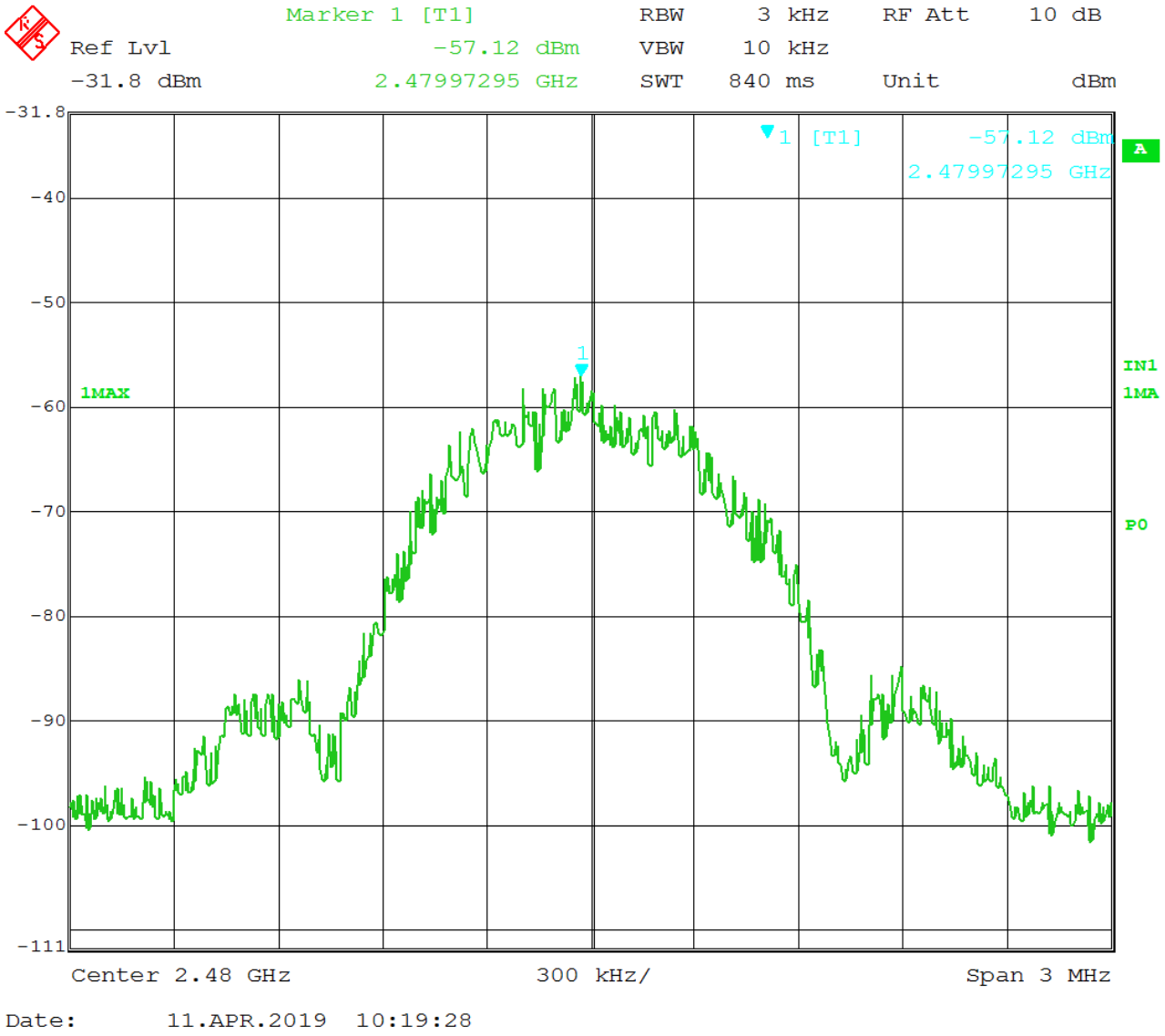

Figure 22 - Power Spectral Density, High Channel

PSD = -57.12 dBm + 107 + CL + AF - 95.23 = -9.45 dBm

CL = cable loss = 7.60 dB
AF = antenna factor = 28.30 dB
107 = conversion from dBm to dBµV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBµV/m) to EIRP (dBm) at a 3m measurement distance

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 dBμV 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 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.
**Sample EIRP Measurements:

Maximum power = -41.06 dBm + 107 + CL + AF - 95.23 = 6.61 dBm*

CL = cable loss = 7.60 dB
AF = antenna factor = 28.30 dB
107 = conversion from dBm to dBμV on a 50Ω measurement system
-95.23 = Conversion from field strength (dBμV/m) to EIRP (dBm) at a 3m measurement distance

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) x antenna distance (m)]^2 / 30

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

Voltage (dBµV) = Power (dBm) + 107 (for 50Ω measurement systems)

Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6

Gain = 1 (numeric gain for isotropic radiator)

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

EIRP = [FS(V/m) x d^2]/30 = FS [0.3] for d = 3

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBµV/m) - 95.23

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

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 END