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DTS
FCC/ISED Test Report

Prepared for: **Garmin International Inc.**

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

Product: **A03346**

Test Report No: **R20180716-20-01B**

Approved by:

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

DATE: **12 December 2018**

Total Pages: **45**

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ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	26 September 2018	Original – NJohnson Prepared by KVepuri
A	5 December 2018	Calibration dates were updated Band edge measurements at restricted band were edited to show absolute field strength levels Note was added that restricted band measurements were measured using radiated values for nonrestricted bands. A note was added to conducted emissions to explain that the plot shows both L and N conductors. -NJ
B	12 December 2018	Section 4.5, Page 30 under "Test procedure" was updated to mention spurious emissions from Part 15.247(d) -NJ

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1.0 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

(1) US Code of Federal Regulations, Title 47, Part 15
(2) ISED RSS-Gen, Issue 5
(3) ISED RSS-247, Issue 2

ANSI C63.10-2013 was used as a test method, with guidance from KBD 558074 D01 v05

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	Pass

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

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary:

EUT	A03346
EUT Received	9/10/2018
EUT Tested	9/12/2018 - 9/14/2018
Serial No.	3974983708 (used for conducted measurements), 3974983703 (used for radiated measurements)
Operating Band	2400 – 2483.5 MHz
Device Type	BTLE
Power Supply	YI Power Adapter (5 VDC output) MN: A8-501000 (Power supply used was a representative power supply only, unit doesn't ship with a power supply)

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
1	2402 MHz
2	2440 MHz
3	2480 MHz

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, middle and highest frequency channels.

2.3 DESCRIPTION OF SUPPORT UNITS

None

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

No.	PERSONNEL	TITLE	ROLE
1	Karthik Vepuri	EMC Test Engineer	Testing
3	Nic Johnson	Technical Manager	Review of Results

Notes:
All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.

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 2019
EMCO Biconilog Antenna	3142B	1647	02 Aug 2017	02 Aug 2018**
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 2019*
Trilithic High Pass Filter	6HC330	23042	09 Mar 2018*	09 Mar 2019*
Rohde & Schwarz LISN	ESH3-Z5	836679/010	26 Jul 2018	26 Jul 2019
RF Cable (preamplifier to antenna)	MFR-57500	01-07-002	09 Mar 2018*	09 Mar 2019*
RF Cable (antenna to 10m chamber bulkhead)	FSCM 64639	01E3872	09 Mar 2018*	09 Mar 2019*
RF Cable (10m chamber bulkhead to control room bulkhead)	FSCM 64639	01E3874	09 Mar 2018*	09 Mar 2019*
RF Cable (Control room bulkhead to RF switch)	FSCM 64639	01E3871	09 Mar 2018*	09 Mar 2019*
RF Cable (RF switch to test receiver)	FSCM 64639	01F1206	09 Mar 2018*	09 Mar 2019*
RF switch – Rohde and Schwarz	TS-RSP	1113.5503.14	09 Mar 2018*	09 Mar 2019*
N connector bulkhead (10m chamber)	PE9128	NCEEBH1	09 Mar 2018*	09 Mar 2019*
N connector bulkhead (control room)	PE9128	NCEEBH2	09 Mar 2018*	09 Mar 2019*

*Internal Characterization

** Extended Cal

Notes:

All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

4.0 DETAILED RESULTS

4.1 DUTY CYCLE

Not Applicable

4.2 RADIATED EMISSIONS

Test Method: ANSI C63.10:2013, Section 6.5, 6.6

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:
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. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.

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:

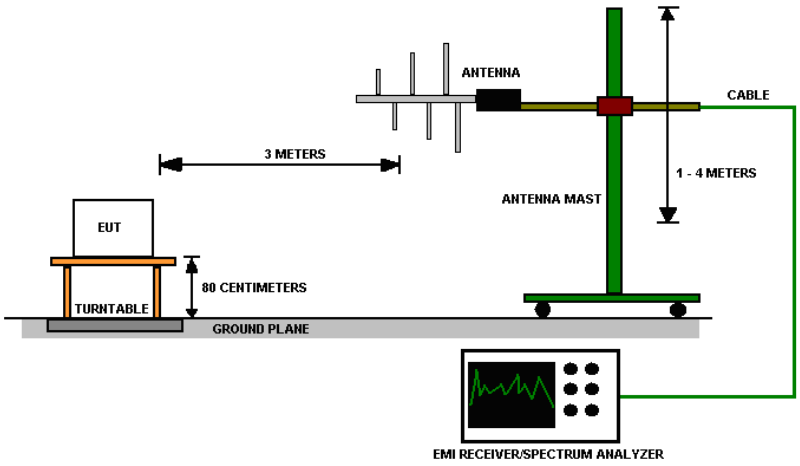

Figure 1 - Radiated Emissions Test Setup

EUT operating conditions
The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest and highest frequency channels.

Test results:

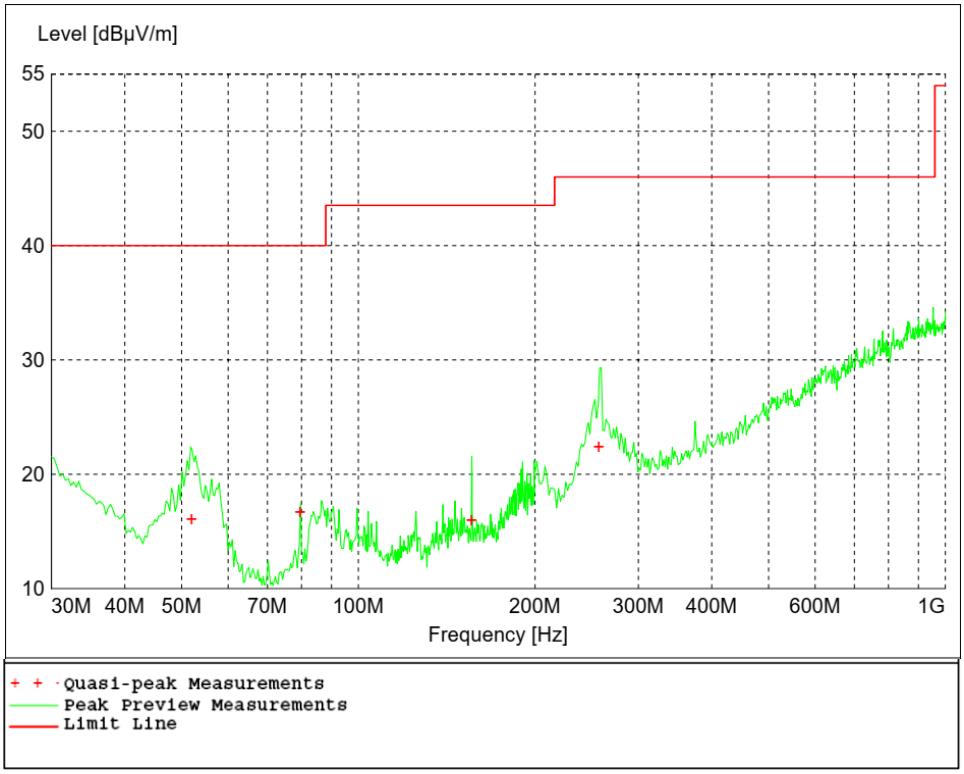

Figure 2 - Radiated Emissions Plot, Receive

Table 1 - Radiated Emissions Quasi-peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
52.020000	16.04	40.00	24.00	100	109	VERT	Z-axis
79.620000	16.69	40.00	23.30	157	78	VERT	Z-axis
156.000000	15.99	43.50	27.50	220	360	HORI	Z-axis
256.980000	22.36	46.00	23.60	100	0	HORI	Z-axis

Table 2 - Radiated Emissions Peak Measurement vs Average Limits, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
2480.200000	43.05	54.00	11.00	105	48	VERT	X-axis
4958.000000	43.22	54.00	10.80	99	106	VERT	X-axis

Peak measurements were compared to average limit and found to be compliant so average measurements were not performed

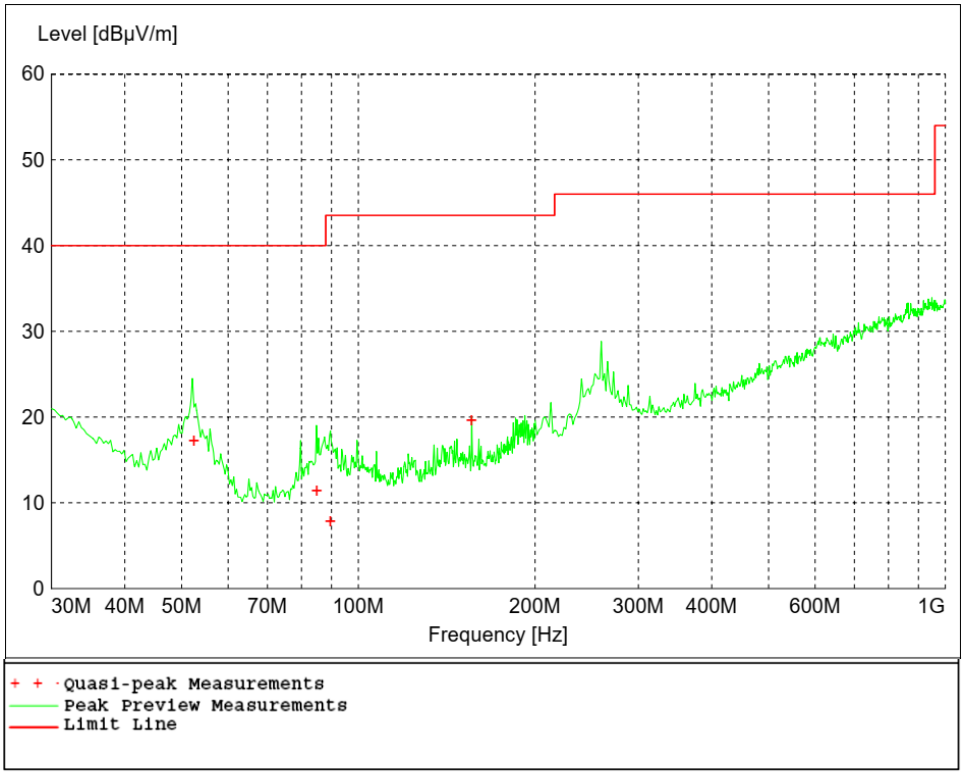

Figure 3 - Radiated Emissions Plot, Low Channel

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

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
52.500000	17.20	40.00	22.80	109	105	VERT	Z-axis
84.960000	11.36	40.00	28.60	169	109	VERT	Z-axis
89.700000	7.89	43.50	35.60	100	105	VERT	Z-axis
156.000000	19.56	43.50	24.00	210	359	HORI	Z-axis

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 4 - Radiated Emissions Peak Measurements vs Average Limits, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
2402.000000	97.08	NA	NA	140	97	HORI	X-axis
4804.000000	45.78	54.00	8.20	137	21	HORI	X-axis
5942.400000	47.50	54.00	6.50	126	146	HORI	X-axis
7192.800000	44.56	54.00	9.40	159	357	VERT	X-axis

Peak measurements were compared to average limit and found to be compliant so average measurements were not performed

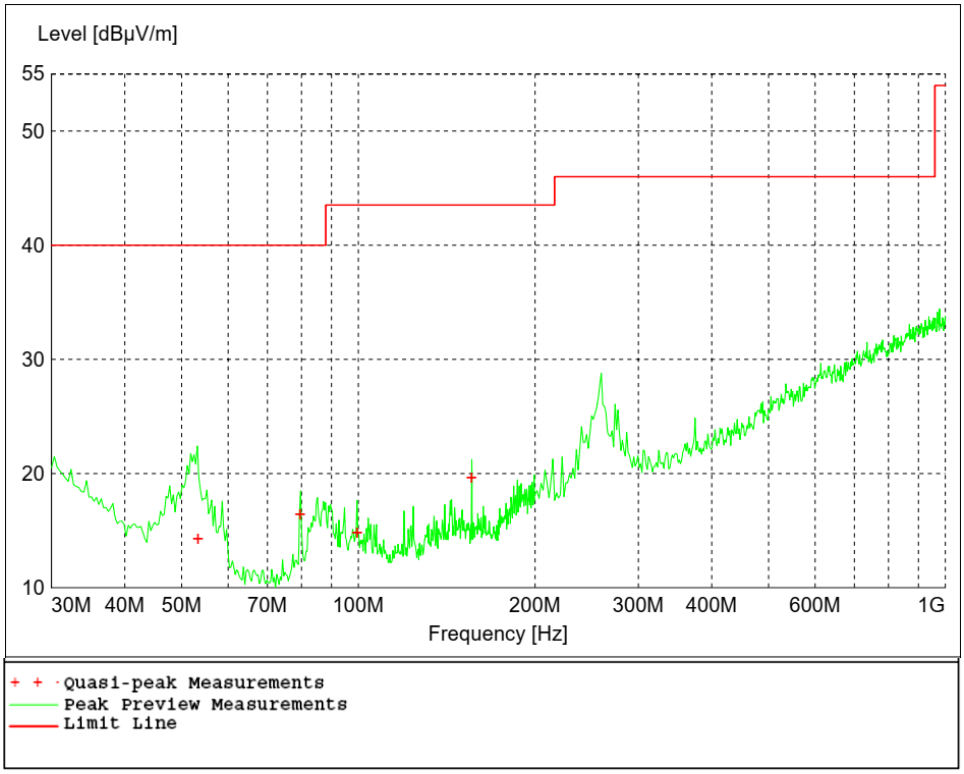

Figure 4 - Radiated Emissions Plot, Mid Channel

Table 5 - Radiated Emissions Quasi-peak Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
53.340000	14.23	40.00	25.80	99	99	VERT	Z-axis
79.620000	16.44	40.00	23.60	163	95	VERT	Z-axis
99.600000	14.80	43.50	28.70	99	360	VERT	Z-axis
156.000000	19.64	43.50	23.90	196	360	HORI	Z-axis

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 6 - Radiated Emissions Peak Measurements vs Average Limits, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
2440.000000	96.85	NA	NA	153	228	HORI	X-axis
4878.600000	42.77	54.00	11.20	98	217	VERT	X-axis
7312.000000	43.58	54.00	10.40	355	332	VERT	X-axis

Peak measurements were compared to average limit and found to be compliant so average measurements were not performed

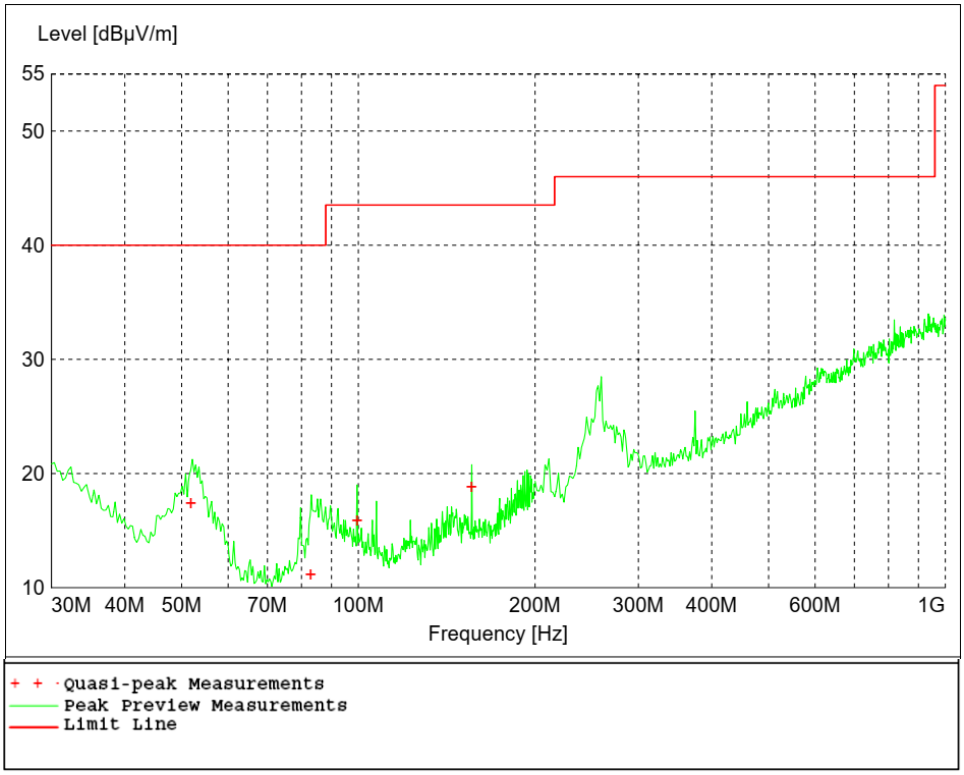

Figure 5 - Radiated Emissions Plot, High Channel

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

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
51.900000	17.36	40.00	22.60	98	100	VERT	Z-axis
82.980000	11.12	40.00	28.90	99	69	VERT	Z-axis
99.540000	15.85	43.50	27.70	101	95	VERT	Z-axis
156.000000	18.84	43.50	24.70	136	334	HORI	Z-axis

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.

Table 8 - Radiated Emissions Peak Measurements vs Average Limits, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol	Axis
MHz	dBµV/m	dBµV/m	dB	cm.	deg.		
2480.000000	95.56	NA	NA	187	107	HORI	X-axis
4955.600000	42.08	54.00	11.90	190	3	VERT	X-axis
7454.800000	41.87	54.00	12.10	149	355	HORI	X-axis

Peak measurements were compared to average limit and found to be compliant so average measurements were not performed

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, Section(s) 11.9.1.1

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

Test procedures:
The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable with 10 MHz RBW and 10 MHz VBW. The RBW was set to a value larger than the DTS bandwidth.
Deviations from test standard:
No deviation.

Test setup:

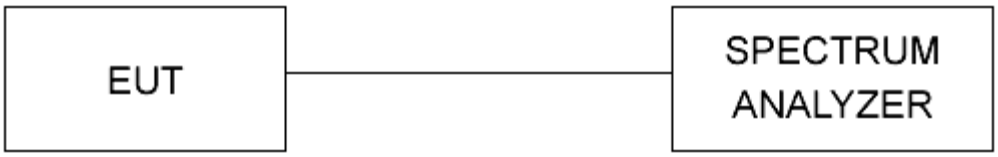

Figure 6 - Peak Output Power Measurements Test Setup

*0.8 dB of cable loss was used and it was accounted for in the plots.

EUT operating conditions:
The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest and highest frequency channel.

Test results:

Peak Output Power

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK OUTPUT POWER (dBm)	Method	RESULT
1	2402 MHz	2.80	Conducted	PASS
2	2440 MHz	2.47	Conducted	PASS
3	2480 MHz	2.33	Conducted	PASS

*0.8 dB of cable loss was used and it was not accounted for in the plots.

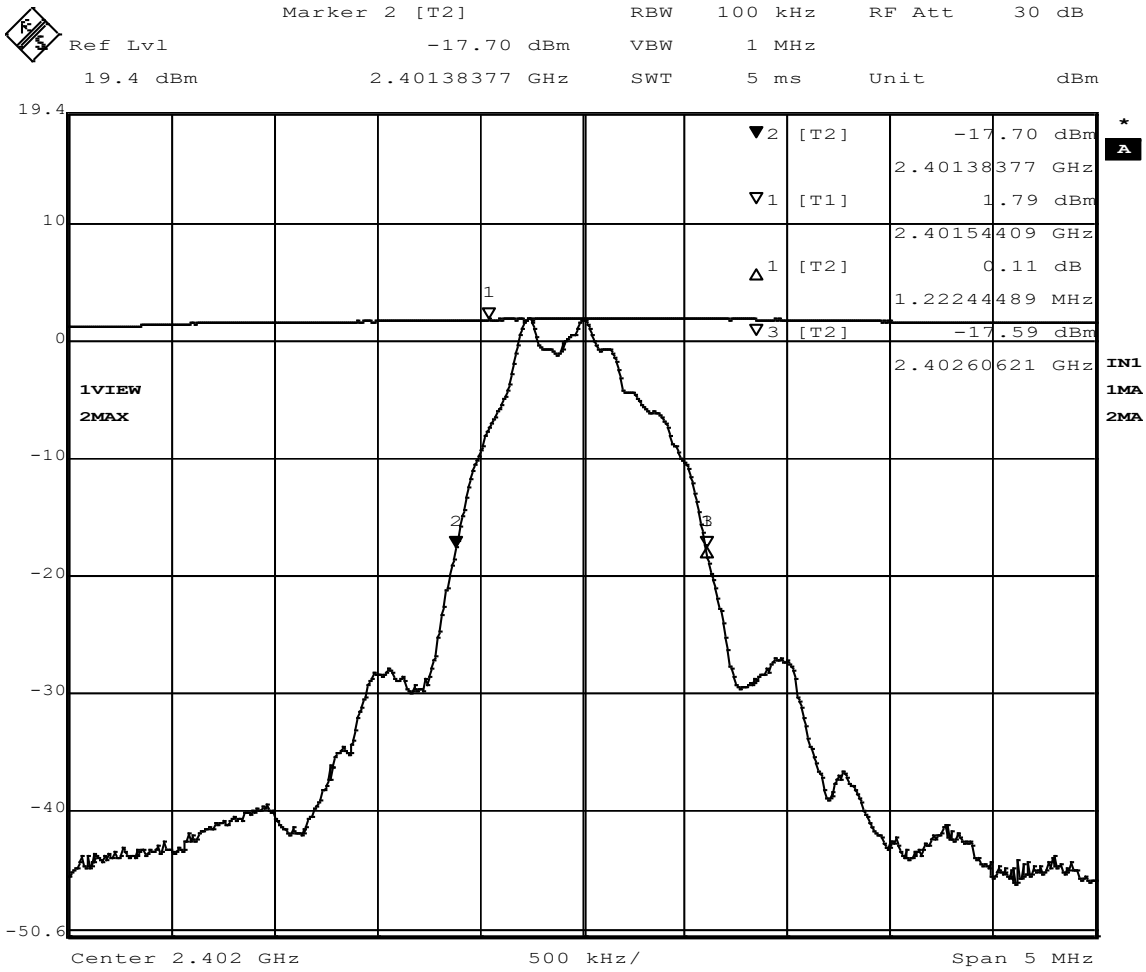

Figure 7 – Output Power

Note*: Trace 1 was measured using a 10 MHz RBW. The waveform was saved on the display, then the RBW was changed to 100 kHz to measure the BW.

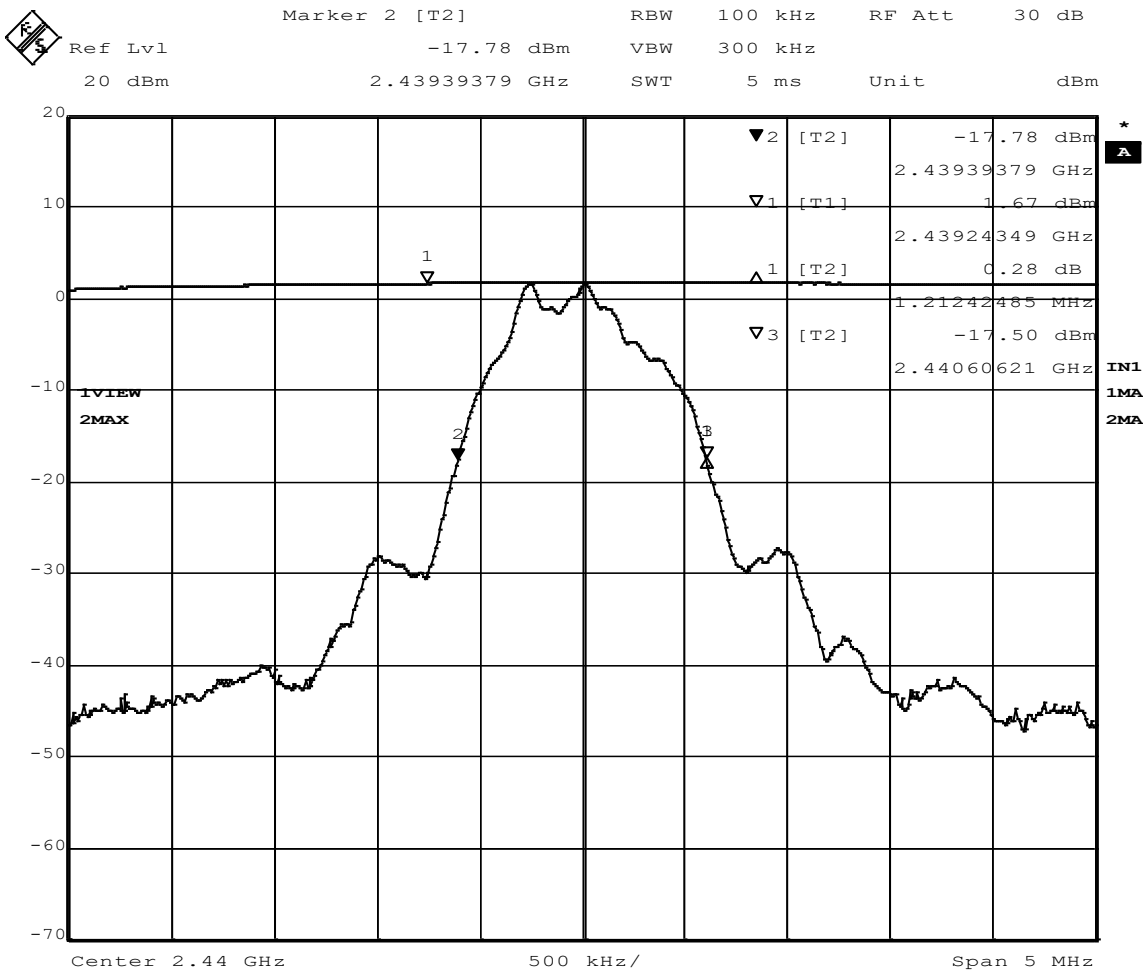

Figure 8 – Output Power

Note*: Trace 1 was measured using a 10 MHz RBW. The waveform was saved on the display, then the RBW was changed to 100 kHz to measure the BW.

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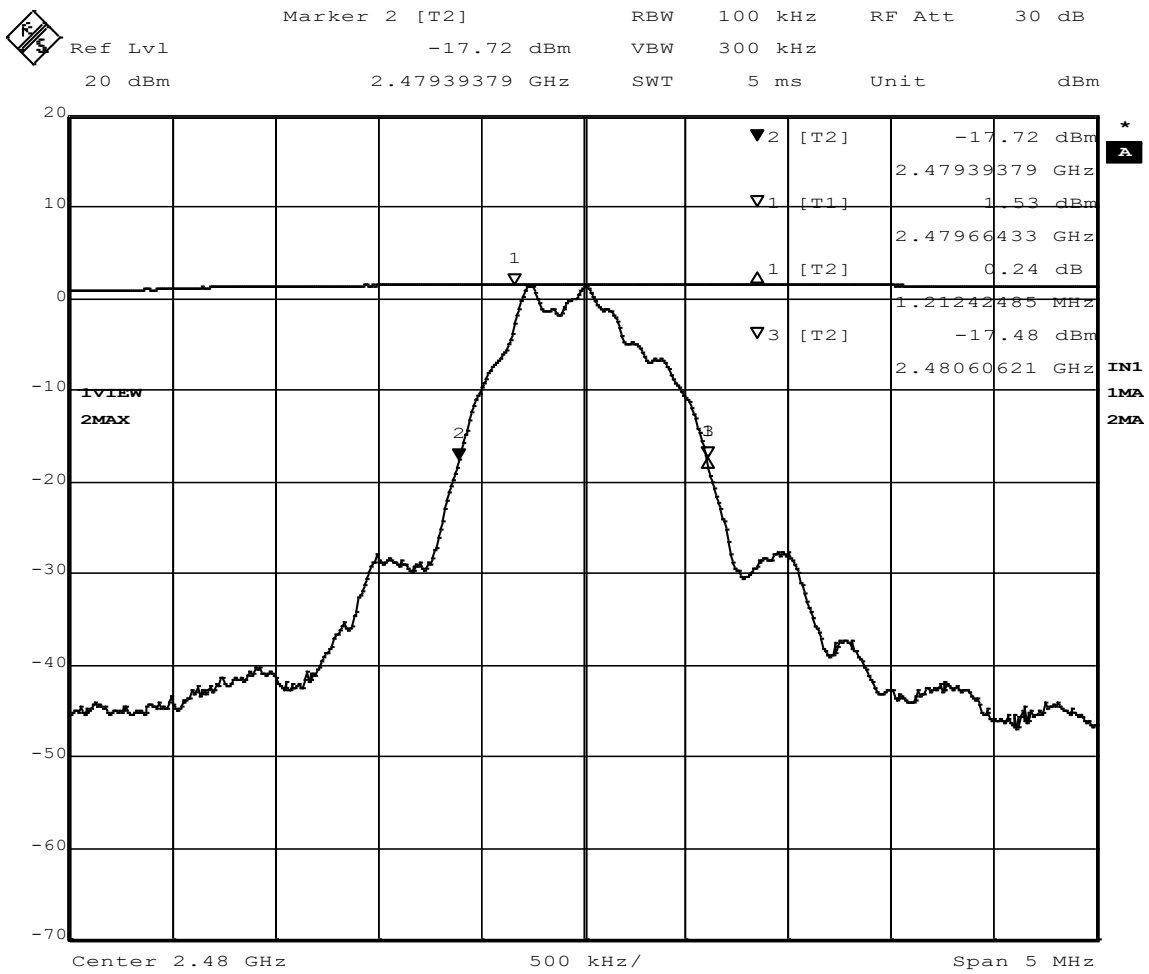

Figure 9 – Output Power

Note*: Trace 1 was measured using a 10 MHz RBW. The waveform was saved on the display, then the RBW was changed to 100 kHz to measure the BW.

4.4 BANDWIDTH

Test Method: ANSI C63.10-2013, Section(s) 6.9.3f), 11.8.1

Limits of bandwidth measurements:

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

Test procedures:
The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 kHz RBW and 300 kHz VBW. The occupied bandwidth was measured using the spectrum analyzers 99% occupied bandwidth setting.

Test setup:

See Section 4.3 for more details.

Deviations from test standard:
No deviation.

Test setup:

Figure 10 - Bandwidth Measurements Test Setup

EUT operating conditions:
The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest and highest frequency channel.

Test results:

Occupied Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	BW (MHz)	RESULT
1	2402 MHz	1.09	PASS
2	2440 MHz	1.11	PASS
3	2480 MHz	1.09	PASS

6 dB Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	BW (kHz)	RESULT
1	2402 MHz	551.10	PASS
2	2440 MHz	551.10	PASS
3	2480 MHz	551.10	PASS

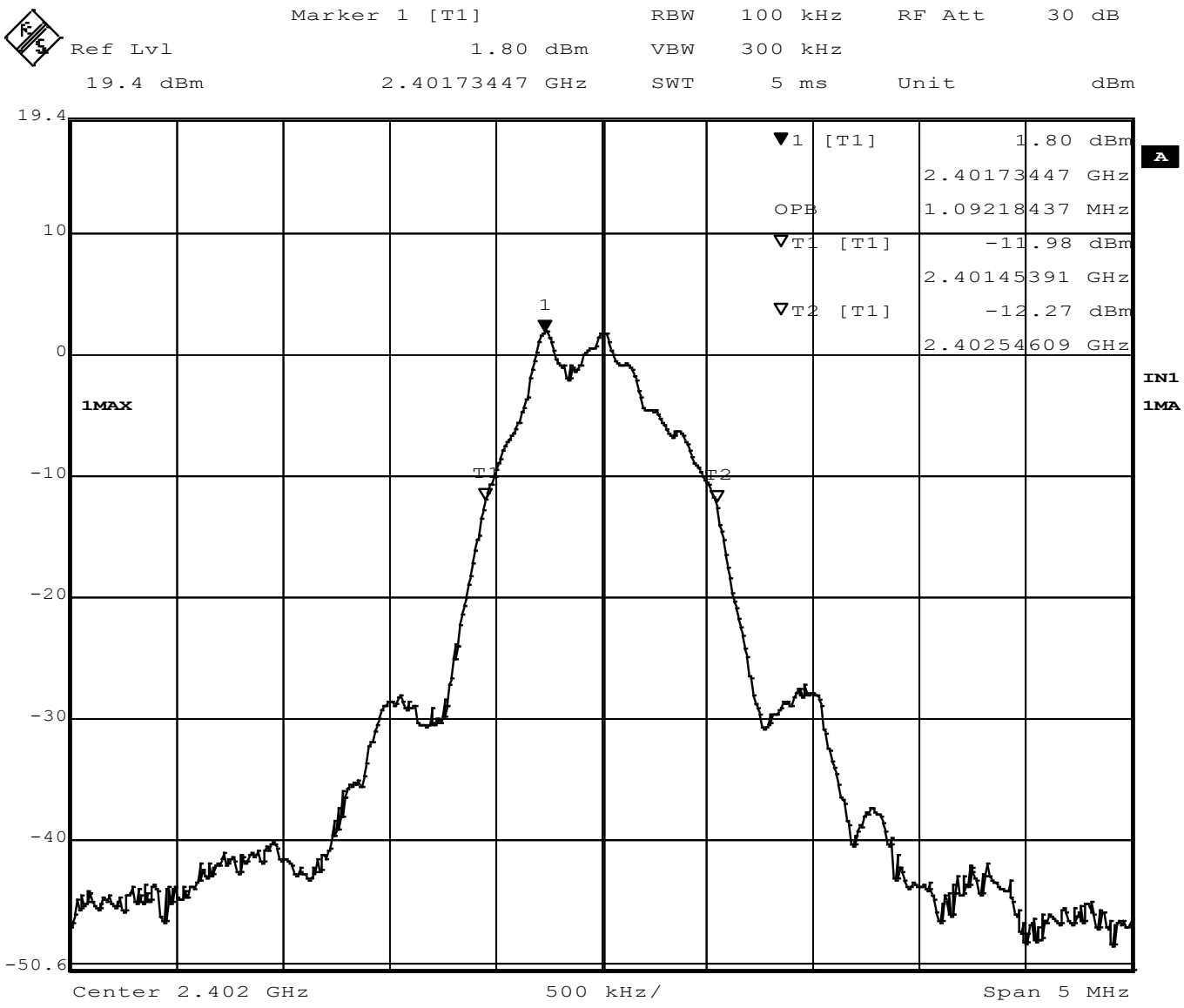

Figure 11 – Occupied Bandwidth, Low Channel

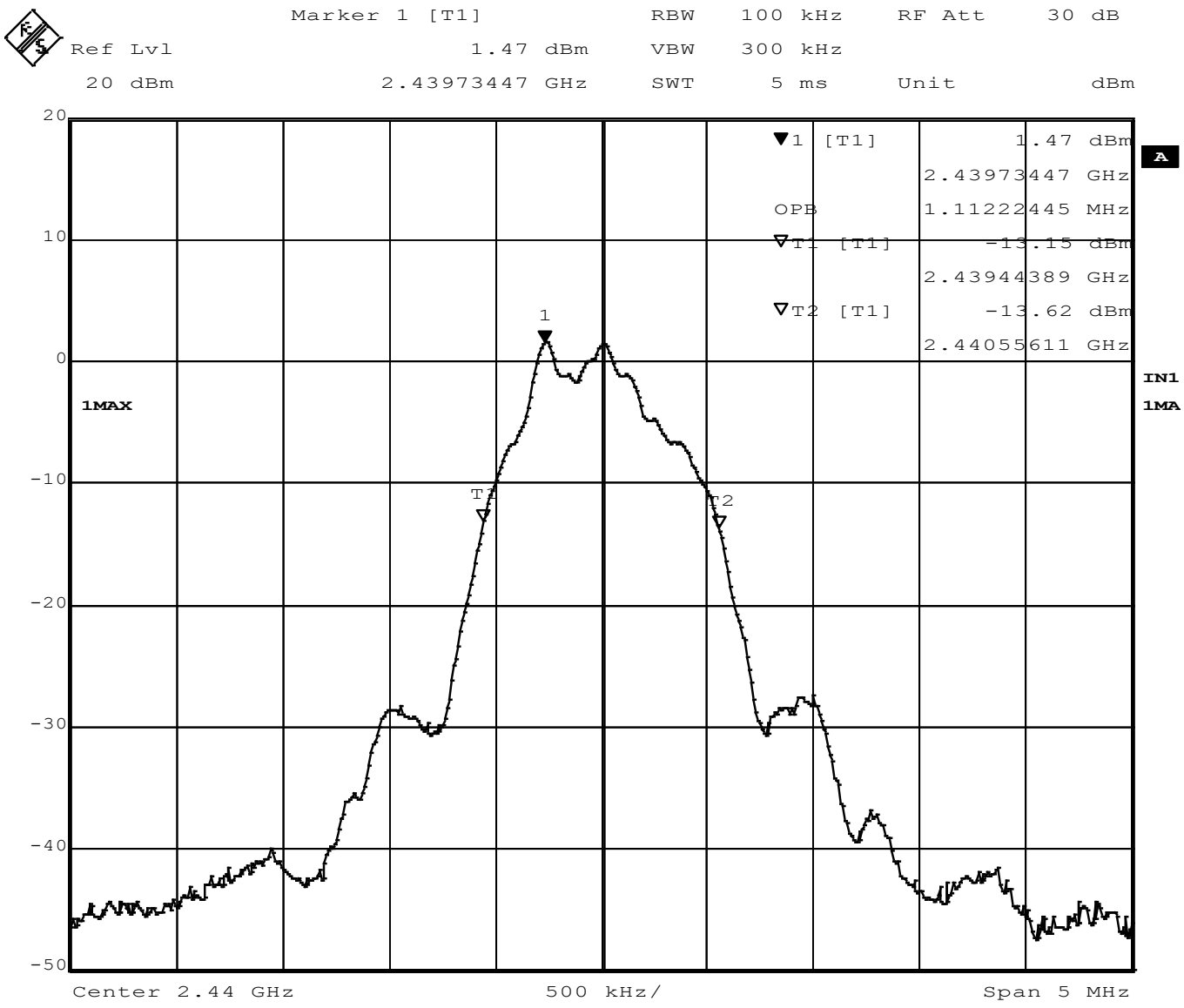

Figure 12 - Occupied Bandwidth, Mid Channel

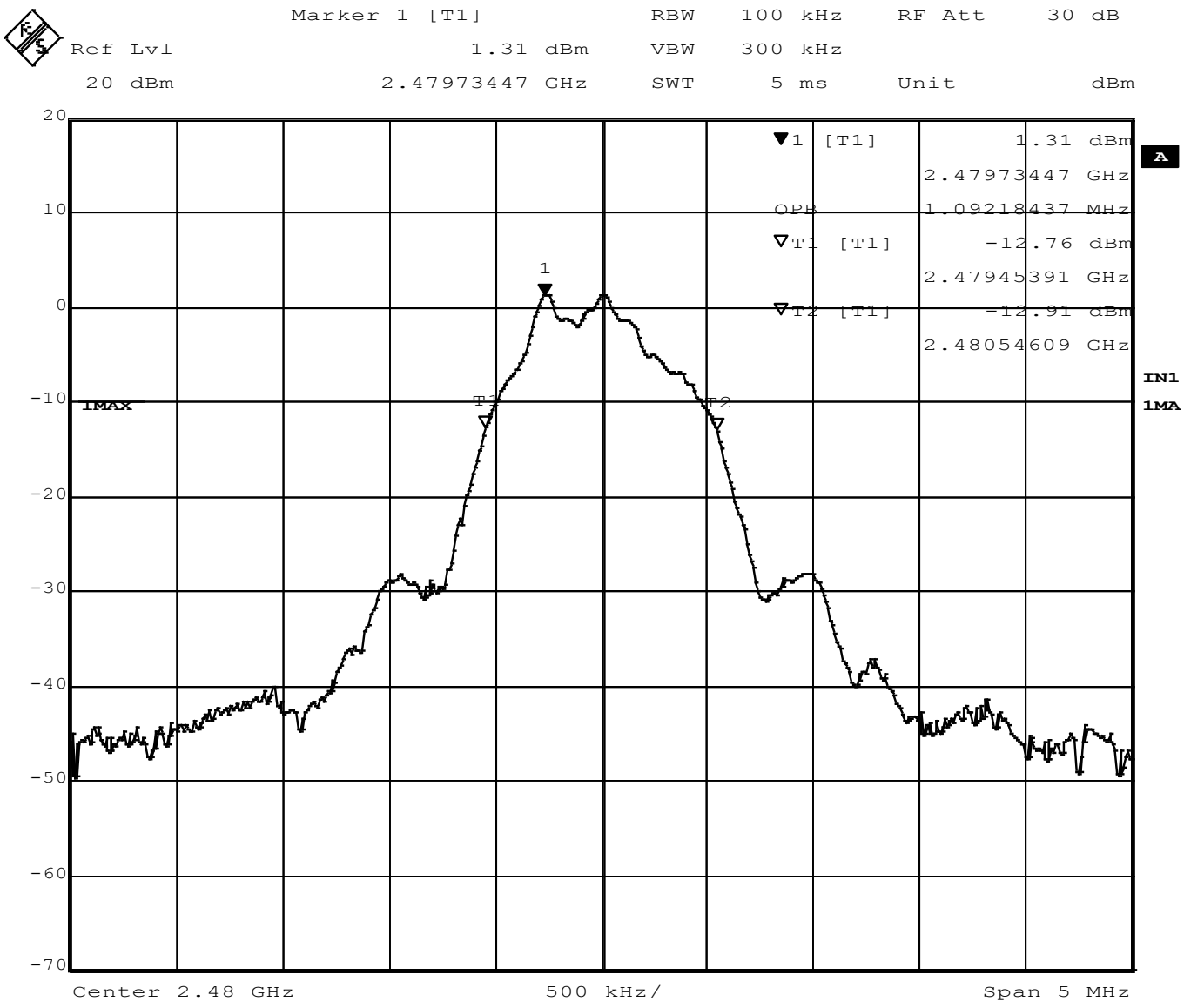

Figure 13 - Occupied Bandwidth, High Channel

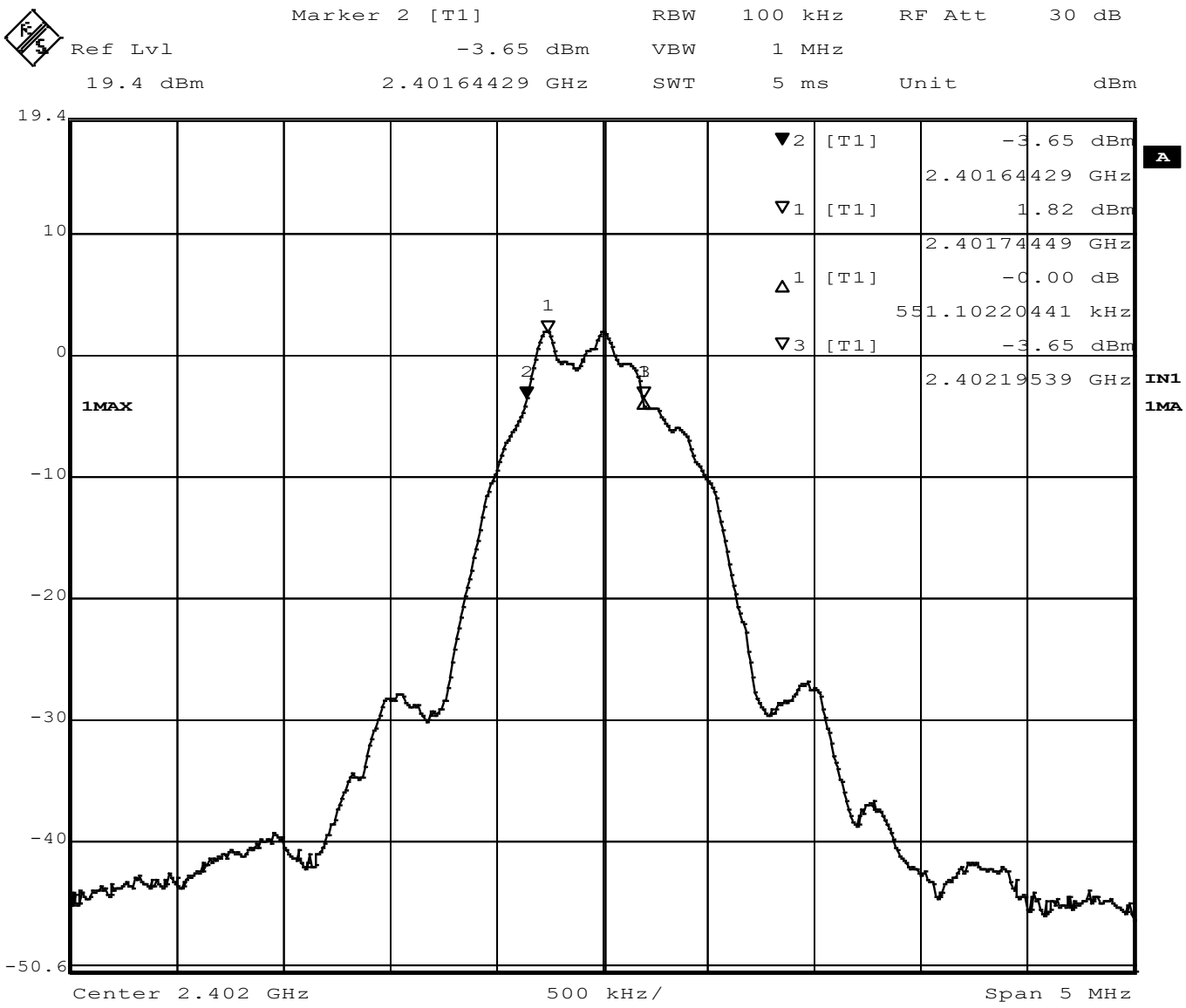

Figure 14 – 6dB Bandwidth, Low Channel

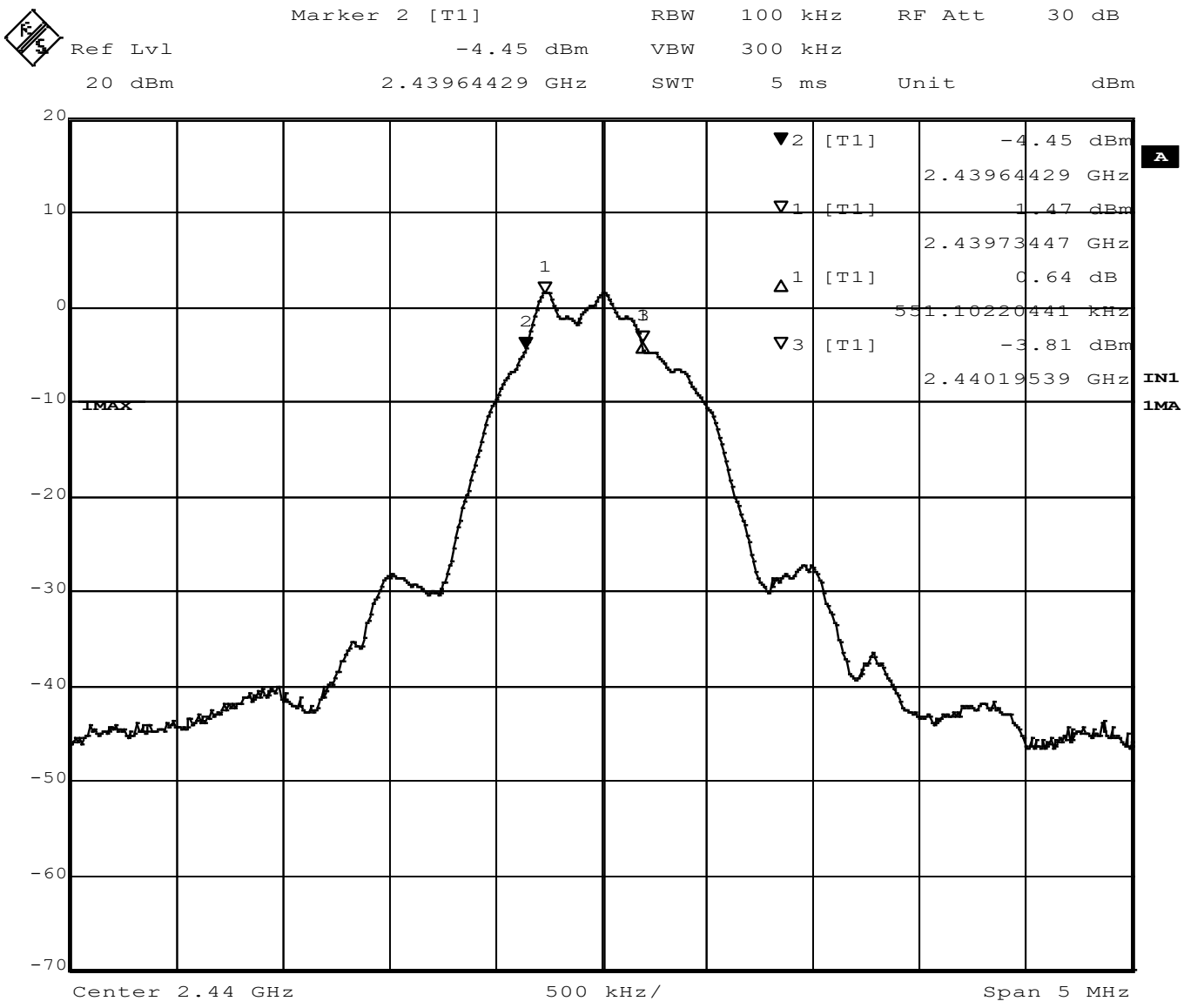

Figure 15 - 6dB Bandwidth, Mid Channel

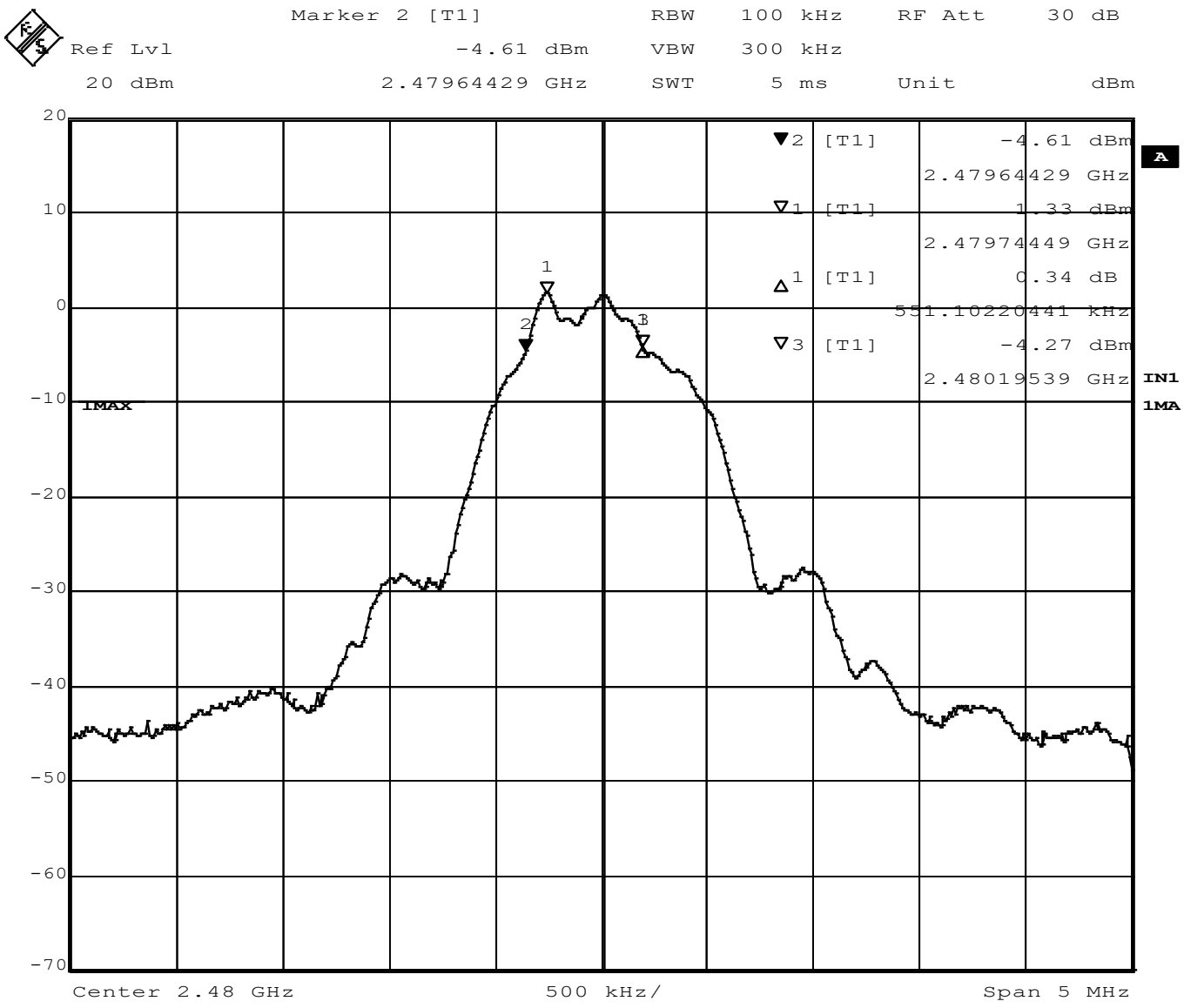

Figure 16 - 6dB Bandwidth, High Channel

4.5 BANDEDGES

Test Method: ANSI C63.10-2013, Section(s) 6.10.6, 11.13.2, 11.11.1

Limits of bandedge measurements:
For emissions outside of the allowed band of operation, 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 EUT was oriented as to produce the maximum emission levels. The resolution bandwidth was set to 100kHz and 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.

All measurements outside of the 2400 -2483.5 MHz band were performed as radiated measurements in Section 3.1. All emissions were found to be at least 20 dB below the fundamental emission.

Deviations from test standard:
No deviation.

Test setup:
All the measurements were done at 3m test distance while an operator was trying to activate the hopping sequence manually.

EUT operating conditions:
The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest frequency channel, and the highest frequency channel.

Test results:

Highest Out of Band Emissions

CHANNEL	Band edge / Measurement Frequency (MHz)	Band	Relative Highest out of band level dBm	Relative Fundamental Level (dBm)	Delta	Min (dB)	Result
1	2400.0	Norestricted Band edge from FCC Part 15.247	-74.33	-48.41	25.92	20.00	PASS
3	2483.5	Nonrestricted Band edge from FCC Part 15.247	-77.01	-49.31	27.70	20.00	PASS

CHANNEL	Band edge / Measurement Frequency (MHz)	Band	Highest out of band Level dBµV/m	Average Limit dBµV/m	Margin	Detector	Result
1	2390.0	Restricted per FCC Part 15.209	17.62	54.00	36.38	Peak	PASS
3	2483.5	Restricted per FCC Part 15.209	16.54	54.00	37.46	Peak	PASS

Highest Out of Band Level = EIRP + 20 log (d) + 104.8

EIRP = Conducted value – cable loss + antenna gain

Conducted value = value at band edge shown in plot, dBm

Cable loss = -0.5 dB

Antenna gain = 0.507 dBi (as declared by manufacturer)

d = 3 meters (distance that limit is specified at)

104.8 – dBm to dBµV conversion on 50 ohm system

Equation taken from ANSI C63.10, Section 11.12.2.2(e)

Peak measurements were compared to average limit

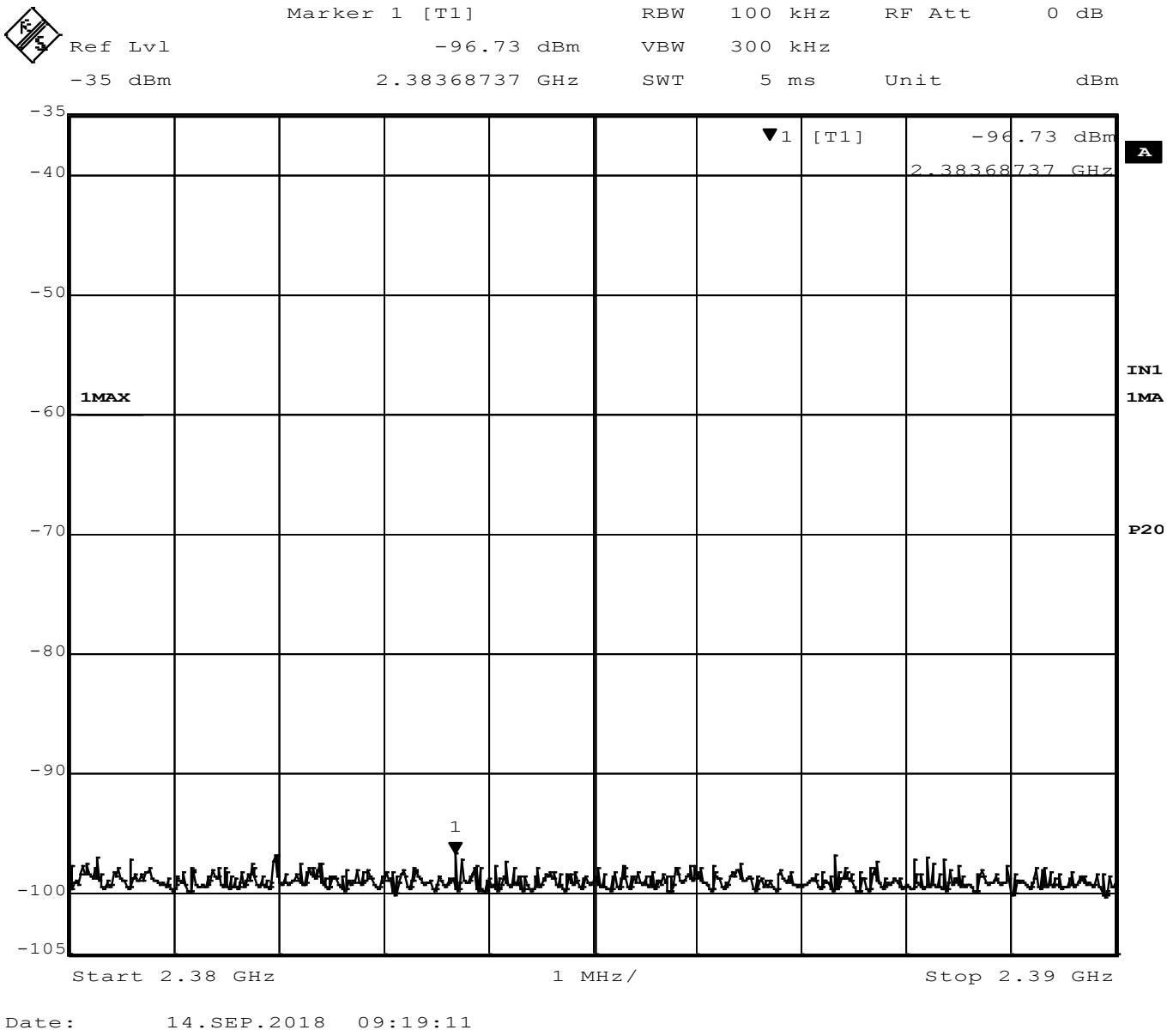

Figure 17 - Band-edge Measurement, Low Channel, Restricted Frequency, Continuous Transmit

The plot shows an uncorrected measurement, used for relative measurements only.

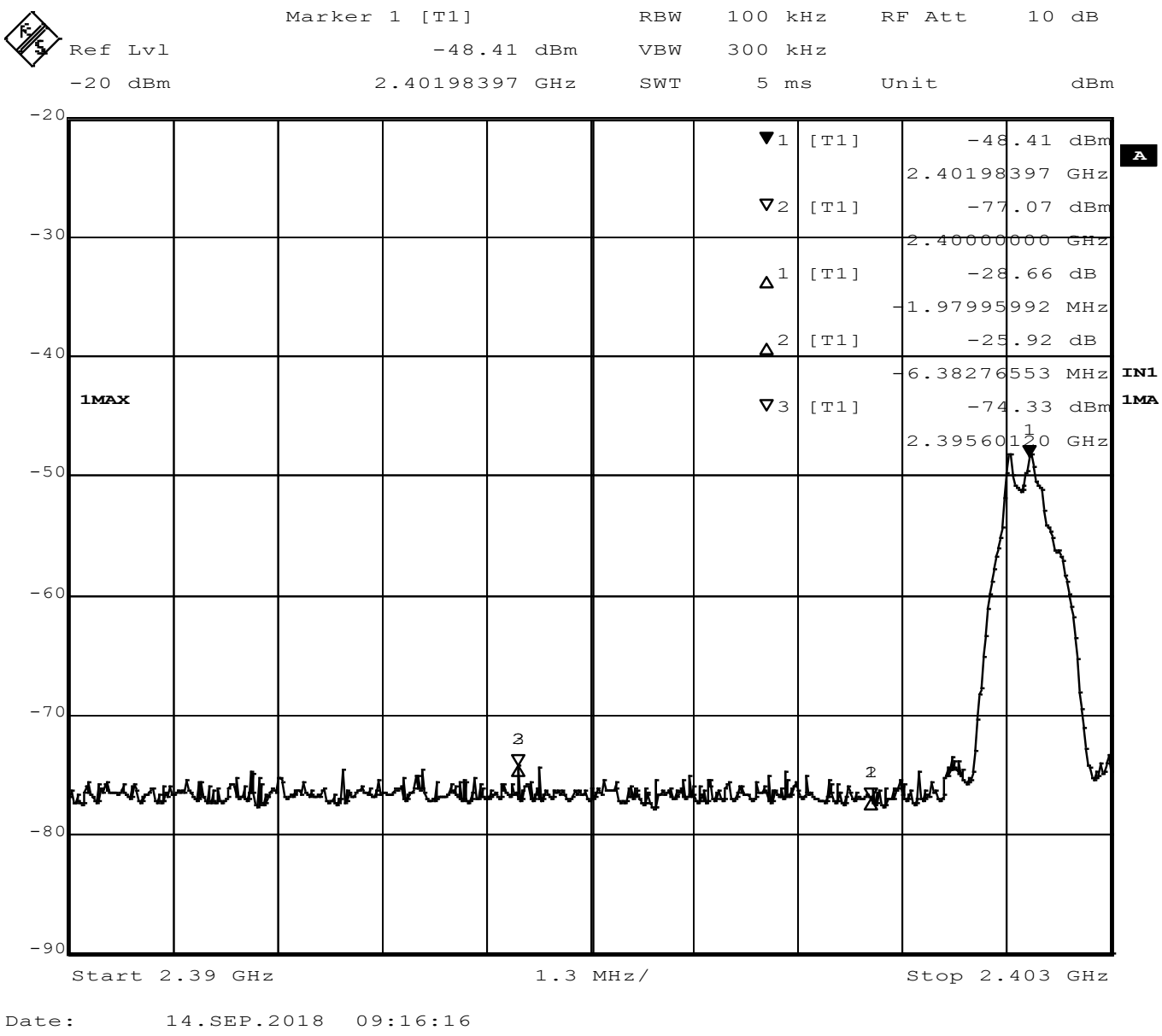

Figure 18 - Band-edge Measurement, Low Channel, Fundamental, Continuous Transmit

The plot shows an uncorrected measurement, used for relative measurements only

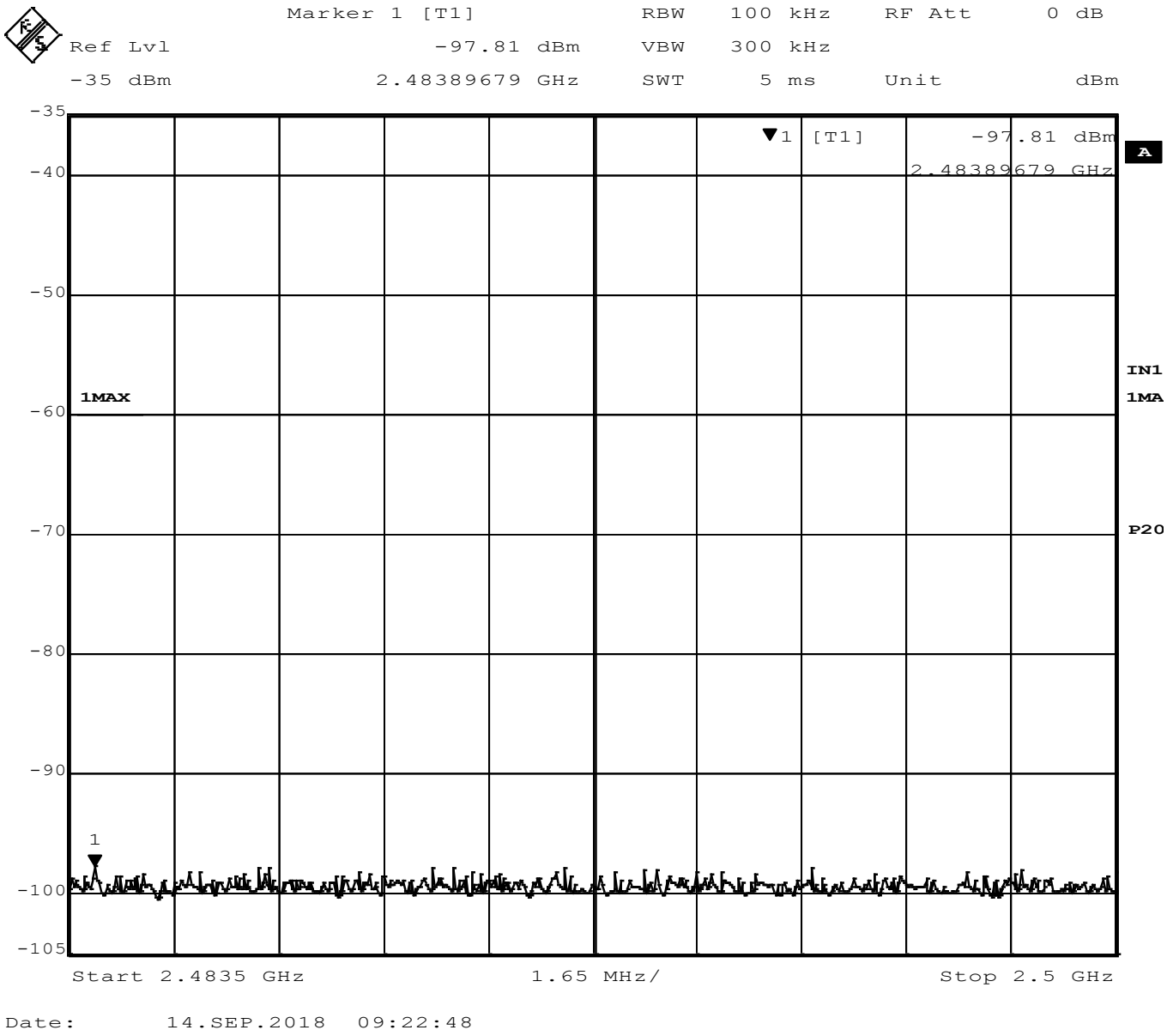

Figure 19 - Band-edge Measurement, High Channel, Restricted Frequency, Continuous Transmit

The plot shows an uncorrected measurement, used for relative measurements only.

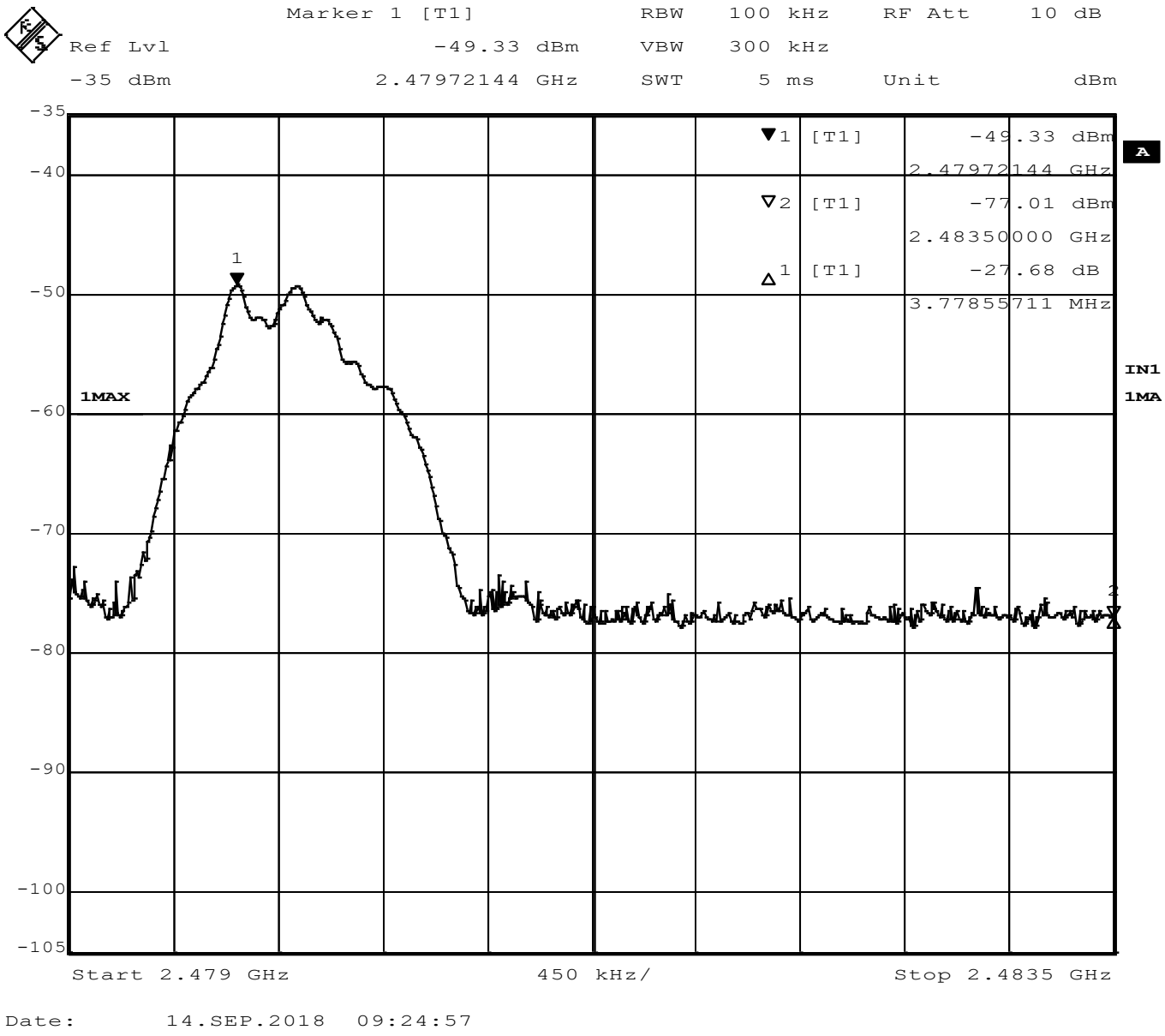

Figure 20 - Band-edge Measurement, High Channel, Fundamental, Continuous Transmit

The plot shows an uncorrected measurement, used for relative measurements only.

4.6 POWER SPECTRAL DENSITY

Test Method: ANSI C63.10, Section 11.10.2

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 5VDC 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:

Power Spectral Density

CHANNEL	CHANNEL FREQUENCY (MHz)	RF POWER LEVEL IN # KHz BW (dBm)	Method	MAXIMUM POWER LIMIT (dBm)	RESULT
1	2402	-14.31	Conducted	8.00	PASS
2	2440	-14.36	Conducted	8.00	PASS
3	2480	-14.73	Conducted	8.00	PASS

*0.8 dB of cable loss was used and it was not accounted for in the plots.

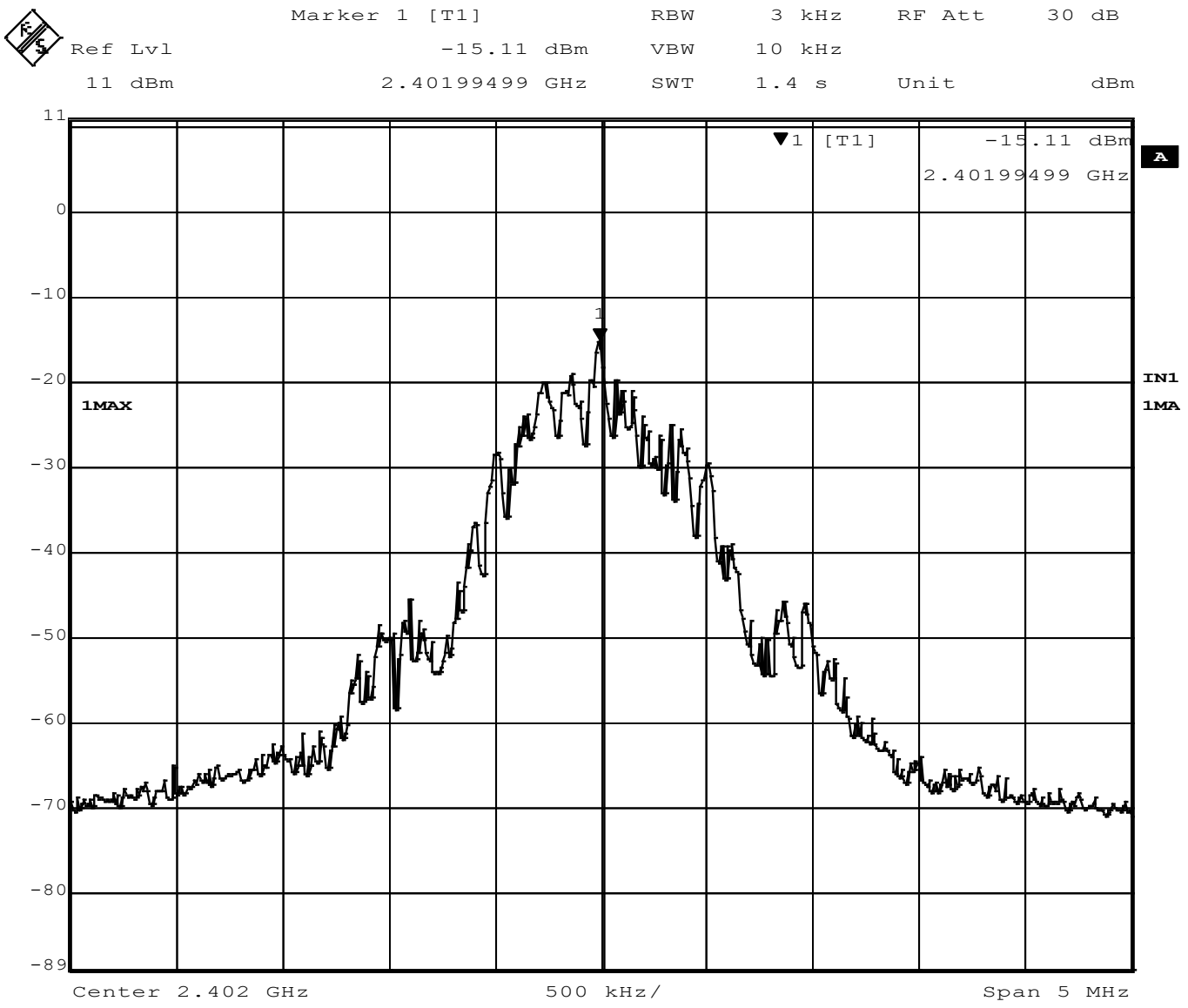

Figure 21 - Power Spectral Density, Low Channel

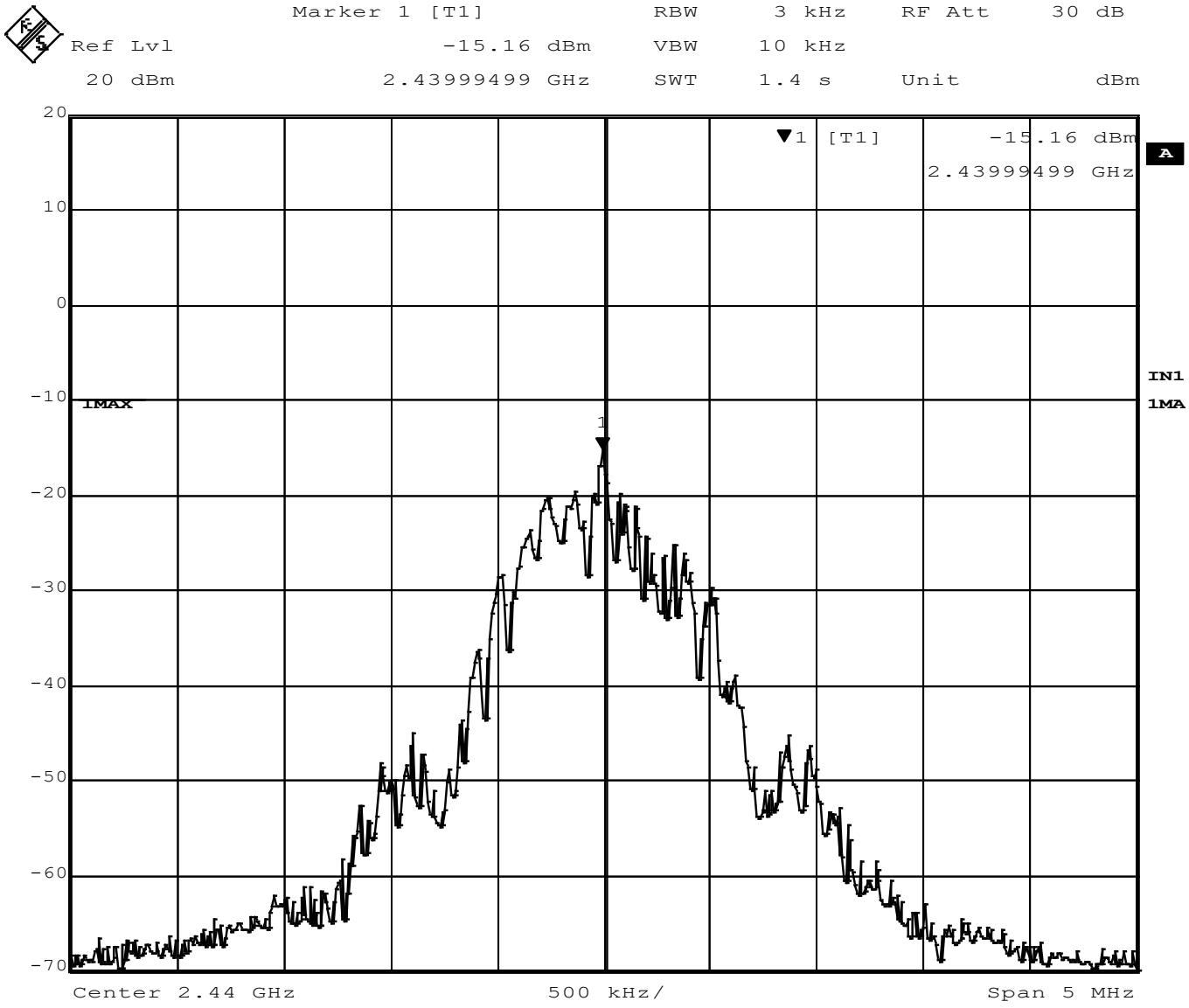

Figure 22 - Power Spectral Density, Mid Channel

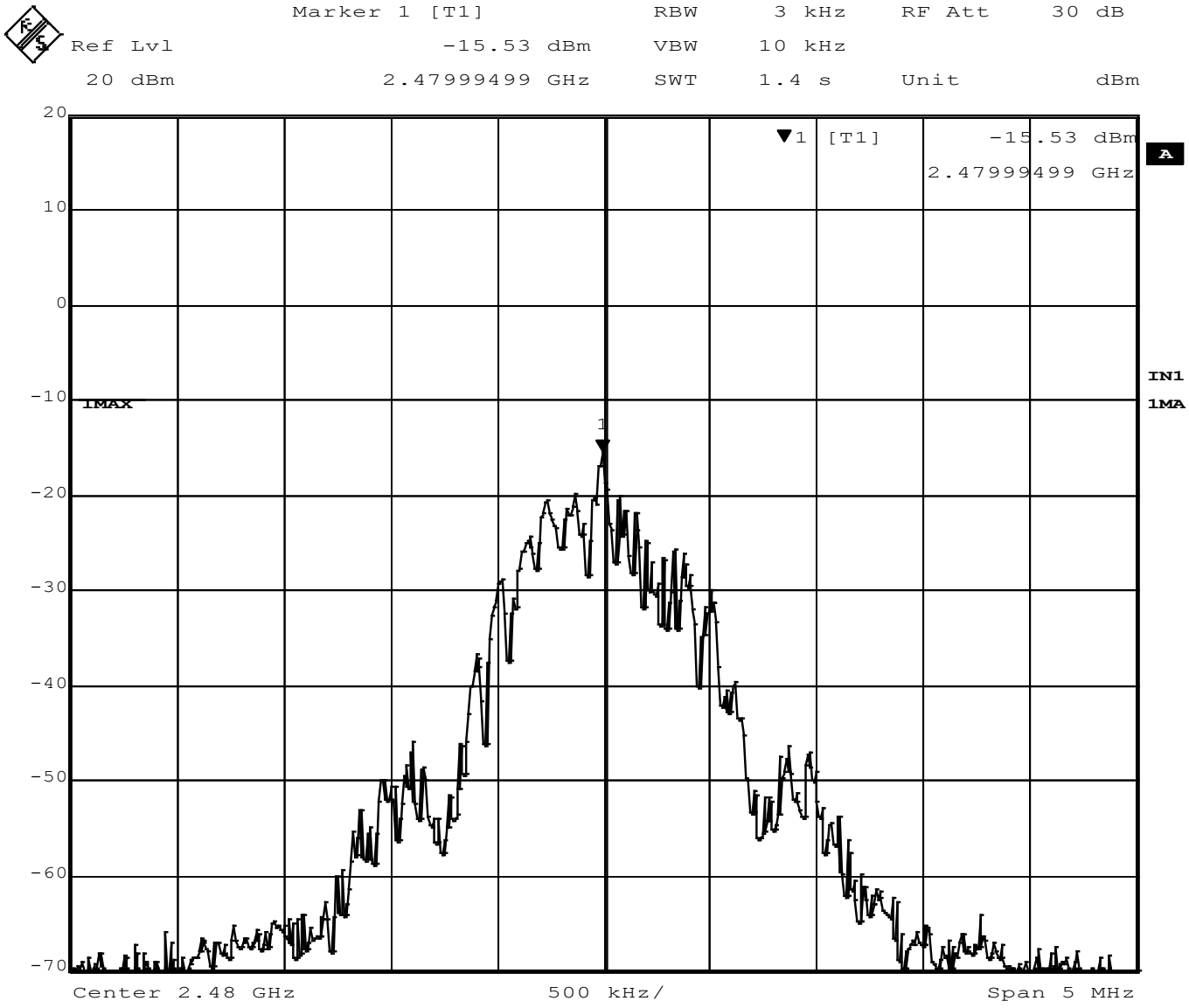

Figure 23 - Power Spectral Density, High Channel

4.7 CONDUCTED AC MAINS EMISSIONS

Test Method: ANSI C63.10-2013, Section(s) 6.2

Limits for conducted emissions measurements:

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Notes:
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

Test Procedures:

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
d. Results were compared to the 15.207 limits.

Deviation from the test standard:
No deviation

EUT operating conditions:
The EUT was powered by 5 VDC unless specified and set to transmit continuously on the middle channel.

Test Results:

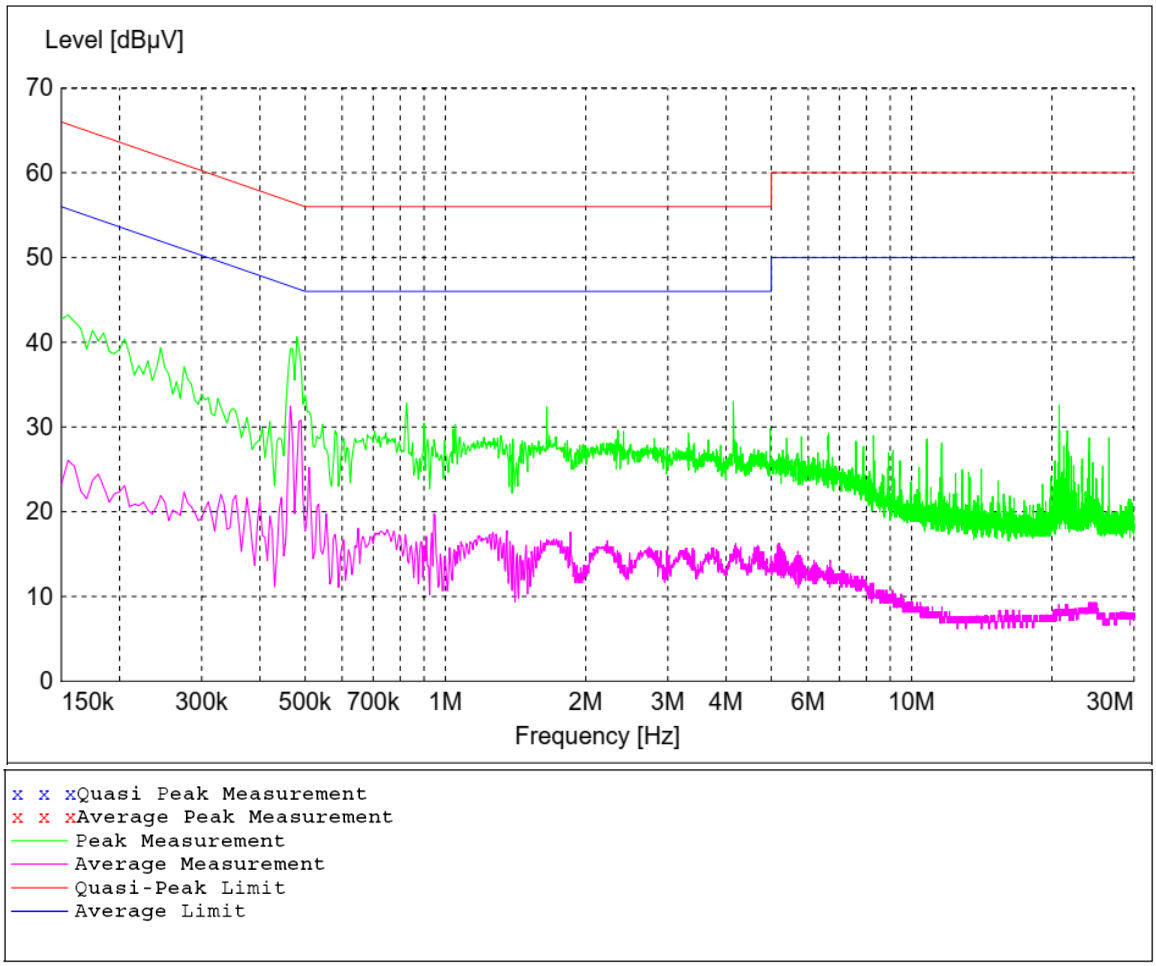

Figure 24 - Conducted Emissions Plot

All Measurements were found to be at least 10 dB below the limits.

The plot shows the composite maximum value of both the line and neutral conductors. It shows the worse case at each frequency.

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.

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
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB

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

REPORT END