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FCC Test Report

Prepared for: **BV Systems**

Address: **8248 Nieman Rd.**
Lenexa, KS 66214

Product: **Lazser Down**

Test Report No: **R20180302-22A**

Approved By:

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Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: **29 May 2019**

Total Pages: **27**

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REVISION PAGE

Rev. No.	Date	Description
0	22 March 2019	Original – NJohnson Prepared by KVepuri
A	30 May 2019	Updated the description in Section 4.1 Includes NCEE Labs report R20180302-22 and its amendment in full. -NJ

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** 5
- **2.3 Description of support units** 5

3.0 Laboratory description **6**

- **3.1 Laboratory description** 6
- **3.2 Test Personnel** 6
- **3.3 Test equipment** 7

4.0 Detailed results **8**

- **4.1 Duty Cycle** 8
- **4.2 Radiated emissions** 8
- **4.3 Peak Output Power** 20
- **4.4 Bandwidth** 22

Appendix A: Sample Calculation **24**

Appendix B – Measurement Uncertainty **26**

REPORT END **27**

1.0 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

APPLIED STANDARDS AND REGULATIONS Test Method: ANSI C63.10-2013		
Standard Section	**Test Type**	**Result**
FCC Part 15.35	Duty Cycle	Pass
FCC Part 15.519(e)	Peak output power	Pass
FCC Part 15.519	Bandwidth	Pass
FCC Part 15.209	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.519 (c) (d) (unrestricted)	Transmitter Radiated Emissions	Pass
FCC Part 15.207	Conducted Emissions	Not applicable. Battery power only, no charger.

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 Lazser Down Transceiver, with MN: LD-1043 and FCC ID: 2ARCX-UWBM1.

EUT	Lazser Down
EUT Received	19 September 2018
EUT Tested	19 September 2018- 19 October 2018
Serial No.	NCEETEST1 (Assigned)
Device Type	Ultra Wide Band (UWB)
Power Supply	Internal Battery (SuPower MN: SP-L2S5P Li-ion)

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 3.5-4.5 GHz.

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on this channel.

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

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 2019
EMCO Biconilog Antenna	3142B	1647	02 Aug 2017	02 Aug 2018
EMCO Horn Antenna	3115	6416	26 Jan 2018	26 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*
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

4.0 DETAILED RESULTS

4.1 DUTY CYCLE

Duty Cycle declared by the manufacturer is 3.5 ms ON time every 50 ms as a user pushes the button. After it has successfully received 10 responses it will display the results and not transmit again until the button is pressed again. If it does not successfully receive 10 responses, it stops transmitting after 10 seconds. Multiple button presses are ignored. The sample tested did not have firmware capability to this so lab has to rely on the declaration provided by the manufacturer for calculations in this report.

4.2 RADIATED EMISSIONS

Test Method: ANSI C63.10:2013, Section 6.5, 6.6, 10.2, 10.3

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.

EUT operating conditions
The EUT was powered by 7.4 VDC unless specified and set to transmit continuously.

Test results:

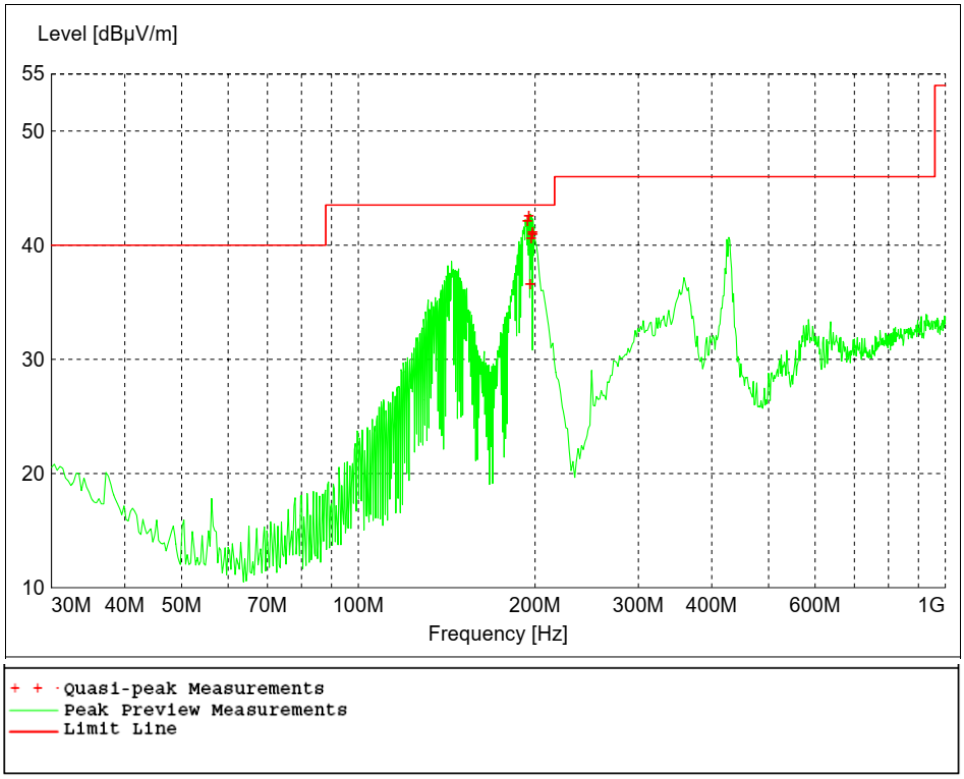

Figure 1 - Radiated Emissions Plot, Receive

Table 1 - Radiated Emissions Quasi-peak Measurements, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
194.400000	42.10	43.50	1.40	263	79	VERT
195.300000	42.55	43.50	1.00	256	104	VERT
196.380000	36.57	43.50	6.90	260	84	VERT
197.100000	40.63	43.50	2.90	223	84	VERT
198.180000	40.98	43.50	2.50	267	69	VERT
198.300000	41.12	43.50	2.40	223	90	VERT

Table 2 - Radiated Emissions Peak Measurements vs. Average Limit, Receive

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
2405.000000	36.19	54.00	17.80	221	242	VERT
5943.000000	46.98	54.00	7.00	157	68	VERT

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

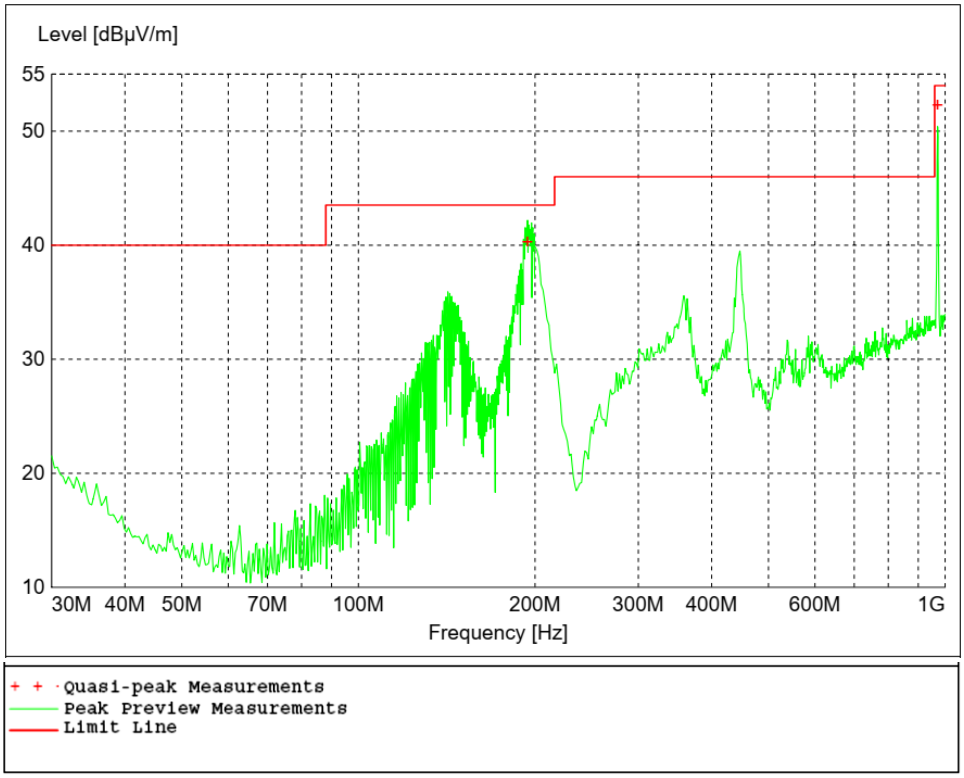

Figure 2 - Radiated Emissions Plot, Transmit

Table 3 - Radiated Emissions Quasi-peak Measurements, Transmit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
194.160000	40.32	43.50	3.20	216	360	VERT
970.860000	52.29	54.00	1.70	106	89	VERT

Table 4 - Radiated Emissions Peak Measurements, Transmit

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
4051.000000	68.41	NA	NA	256	185	VERT
4119.200000	69.10	NA	NA	285	192	VERT

.

Table 5 - Radiated Emissions Peak Measurements, Transmit, Part 15.519

Frequency Range	EIRP Level	Receiver reading	Antenna Factor	Cable Factor	Pre-amplifier Gain	Duty Cycle	Limits	RBW	Margin
MHz	dBm	dBm	dB	dB		dB	dBm		
960-1000	-88.83	-74.71	23.7	4.9	-31.4	-23.09	-75.30	1 MHz	13.53
1610-1990	-93.41	-84.00	27.31	6.8	-32.2	-23.09	-63.30	1 MHz	30.11
1990-3100	-93.39	-84.14	27.27	6.9	-32.1	-23.09	-61.30	1 MHz	32.09
3100-10600	-71.75	-70.51	32.48	9.7	-32.1	-23.09	-41.30	1 MHz	30.45
Above 10600	-85.48	-95.20	38.84	12.6	-30.4	-23.09	-61.30	1 MHz	24.18
1164-1240	-126.00	-113.66	24.78	5.5	-31.3	-23.09	-85.30	1 kHz	40.70
1559-1610	-129.62	-118.00	25.4	6.1	-31.8	-23.09	-85.30	1 kHz	44.32

EIRP Level = Raw value+ AF+ CF+ PA Gain+ Duty Cycle+ 107- 95.23

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. The EUT was measured in all 3 orthagonal axis. It was found that the Y-axis produced the highest emissions, and this orientation was used for all testing. See the test setup photo exhibit for details on the orientations

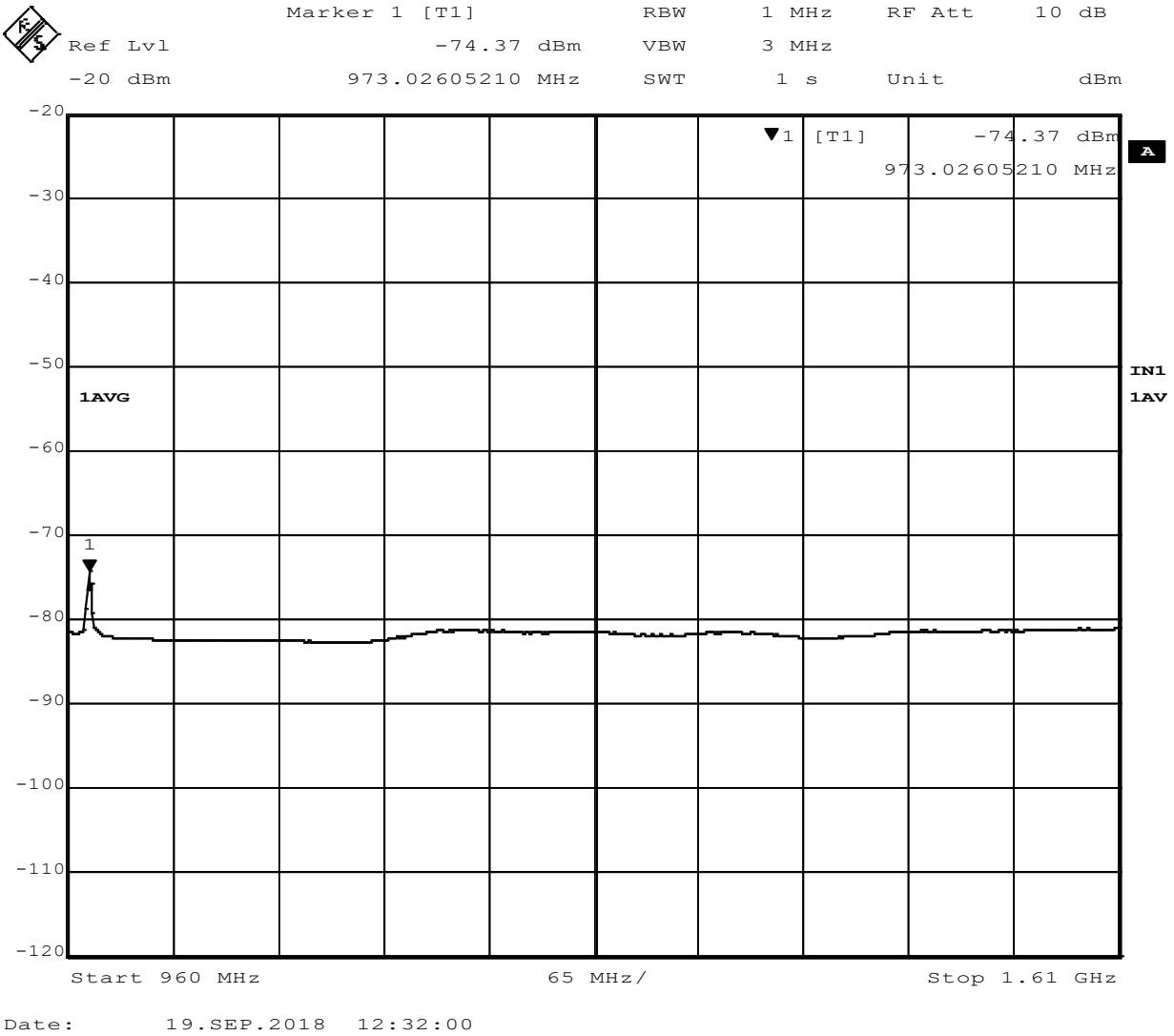

Figure 3 - Radiated Emissions Plot, Transmit 960 MHz- 1.61 GHz

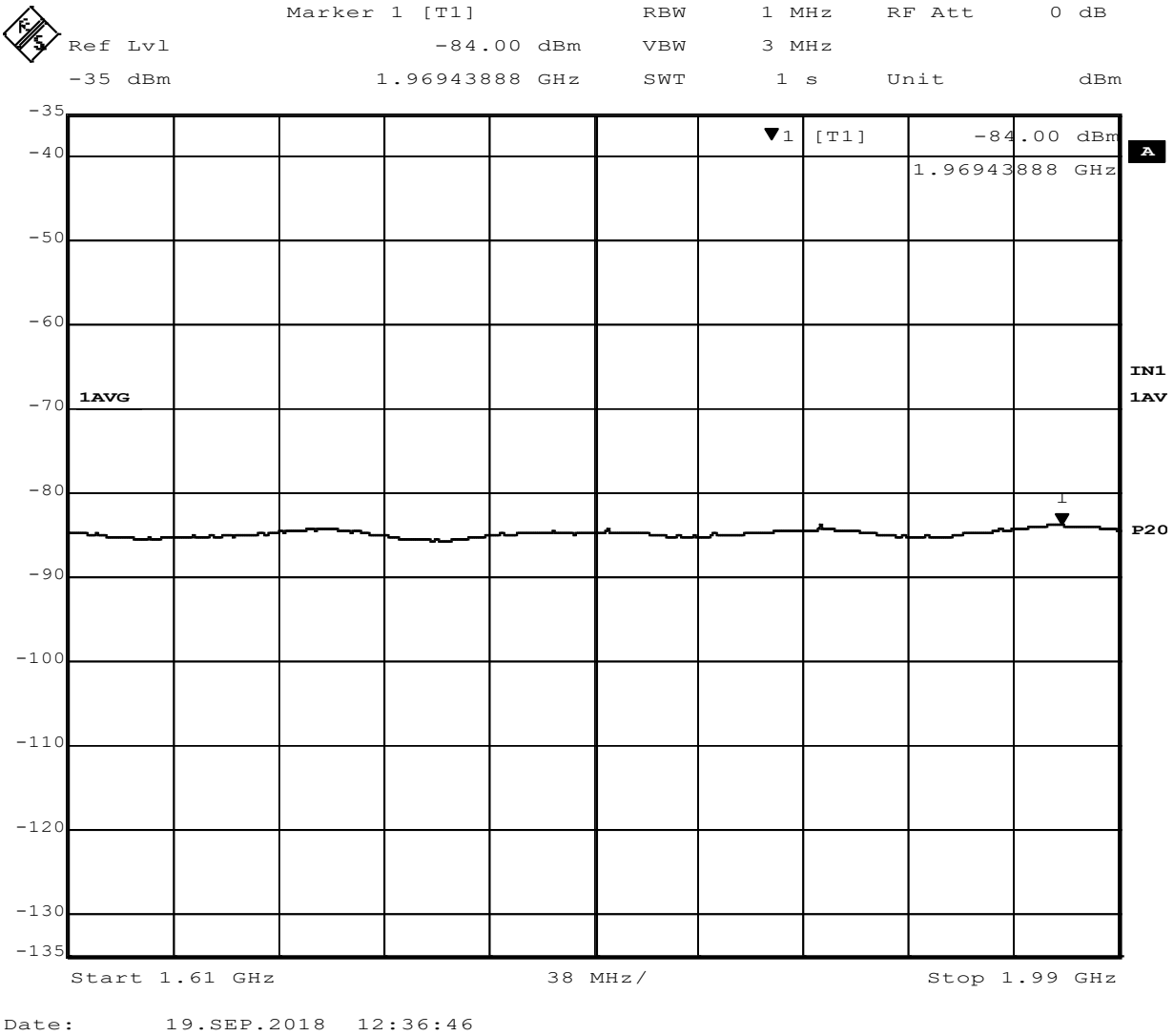

Figure 4 - Radiated Emissions Plot, Transmit 1.61-1.99 GHz

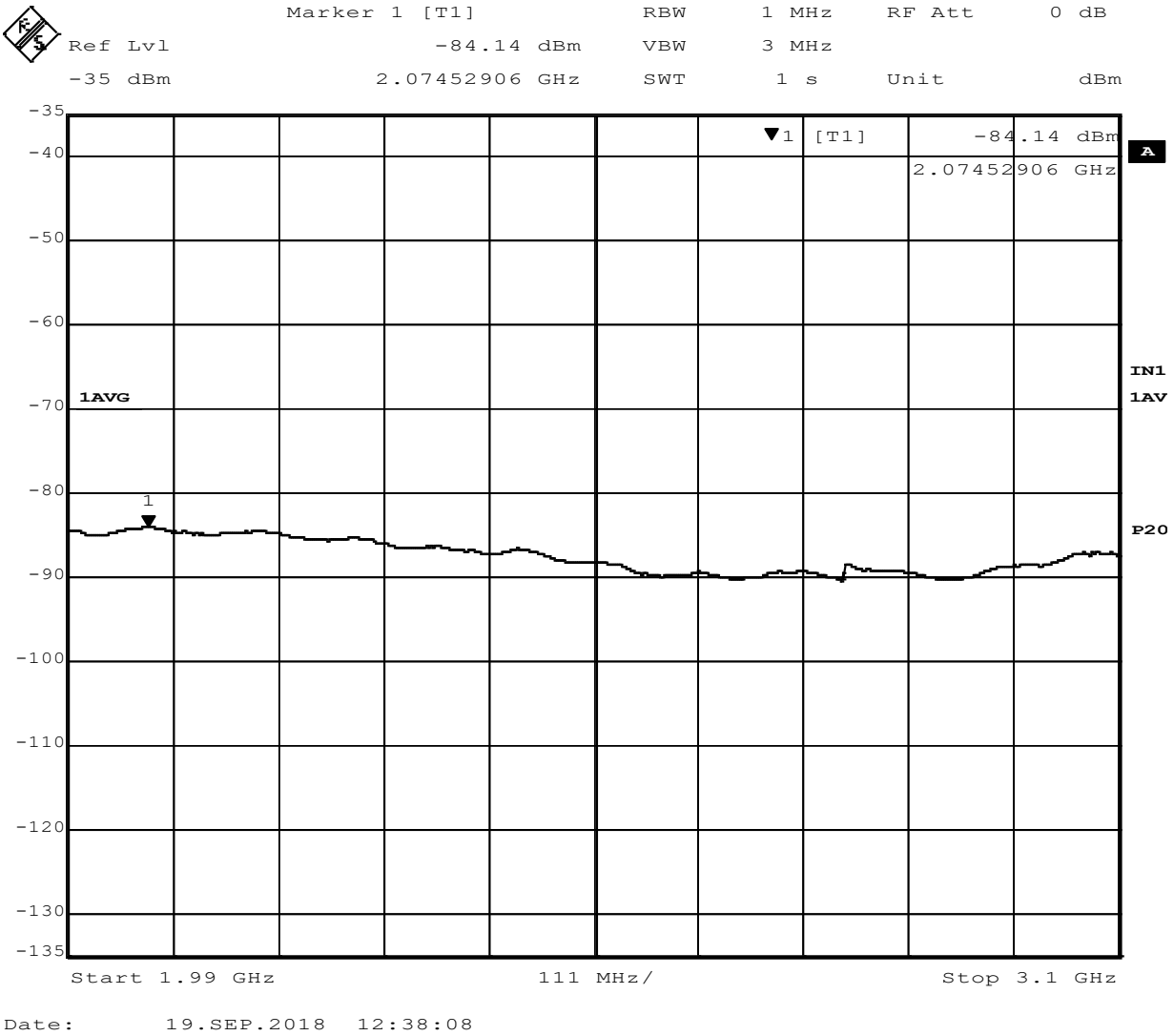

Figure 5 - Radiated Emissions Plot, Transmit 1.99-3.1 GHz

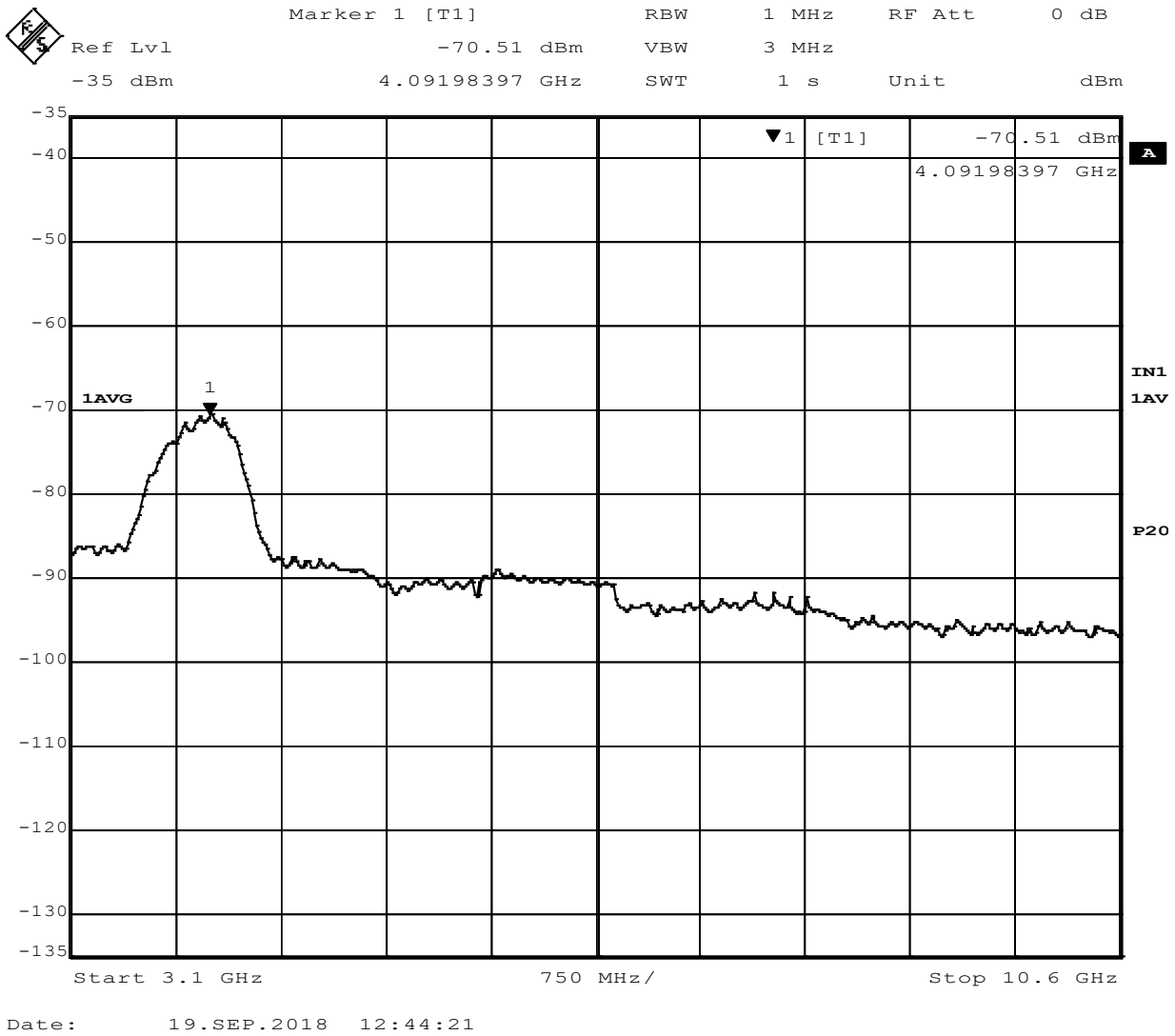

Figure 6 - Radiated Emissions Plot, Transmit 3.1.16-10.6 GHz

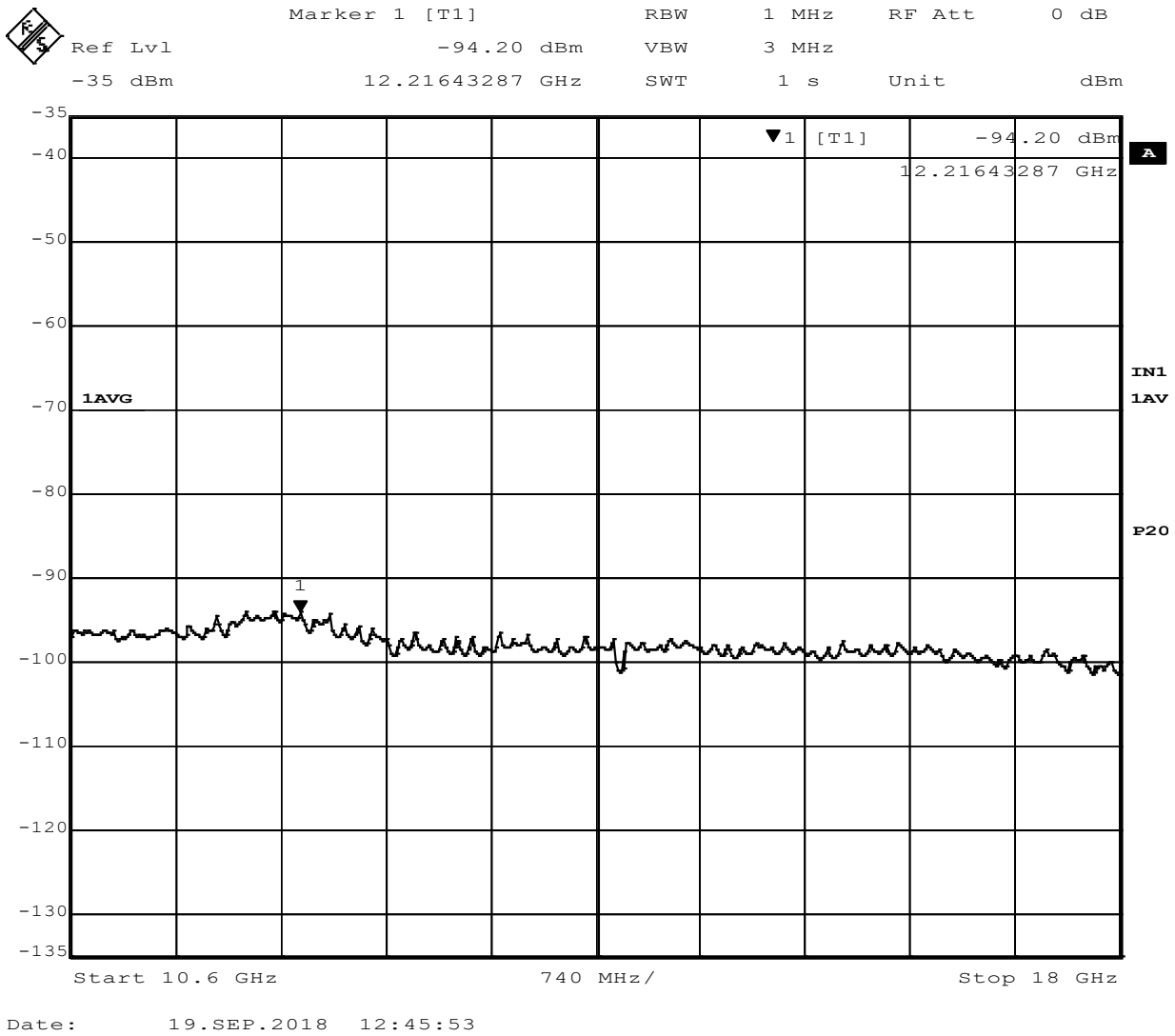

Figure 7 - Radiated Emissions Plot, Transmit 10.6-18.0 GHz

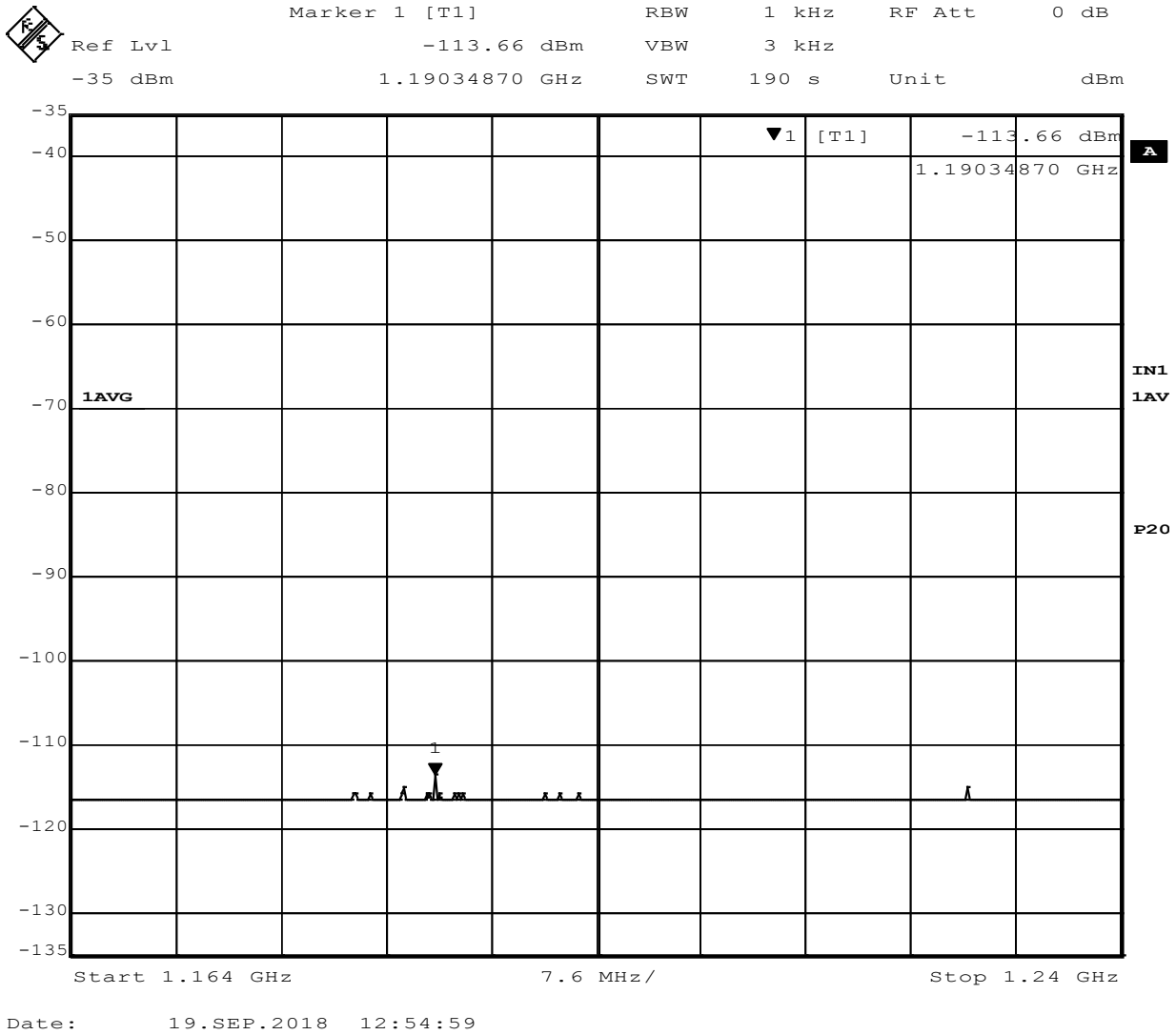

Figure 8 - Radiated Emissions Plot, Transmit 1.16-1.24 GHz

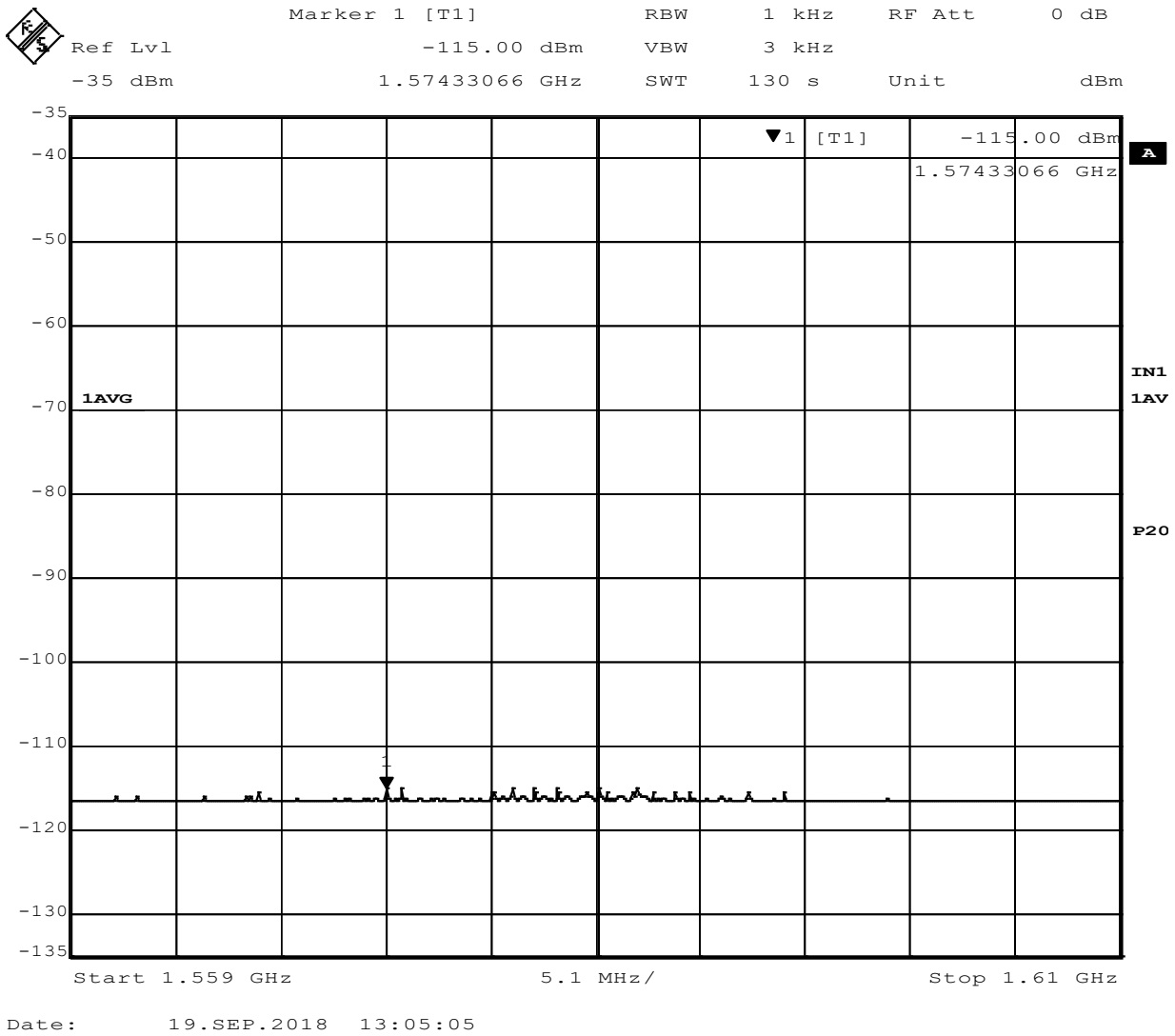

Figure 9 - Radiated Emissions Plot, Transmit 1.559-1.61 GHz

4.3 PEAK OUTPUT POWER

Test Method: ANSI C63.10, Section(s) 10.3.6, 10.3.9

Limits of bandwidth measurements:
The maximum allowed peak output power is 0 dBm with 50MHz RBW.

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

Deviations from test standard:
No deviation.

Test setup:

See Section 4.2

EUT operating conditions:
The EUT was powered by 7.4 VDC unless specified and set to transmit continuously.

Test results:

Peak Output Power

CHANNEL FREQUENCY (MHz)	PEAK OUTPUT POWER (dBm)	Limit*	Method	RESULT
3993.6	-48.03	-34	EIRP	Pass

*Limit was calculated based on RBW (20log(1/50)) to correspond to the limit for a 1 MHz RBW measurement with BW conversion. See ANSI C63.10-2013, Sec. 10.3.6 for details.

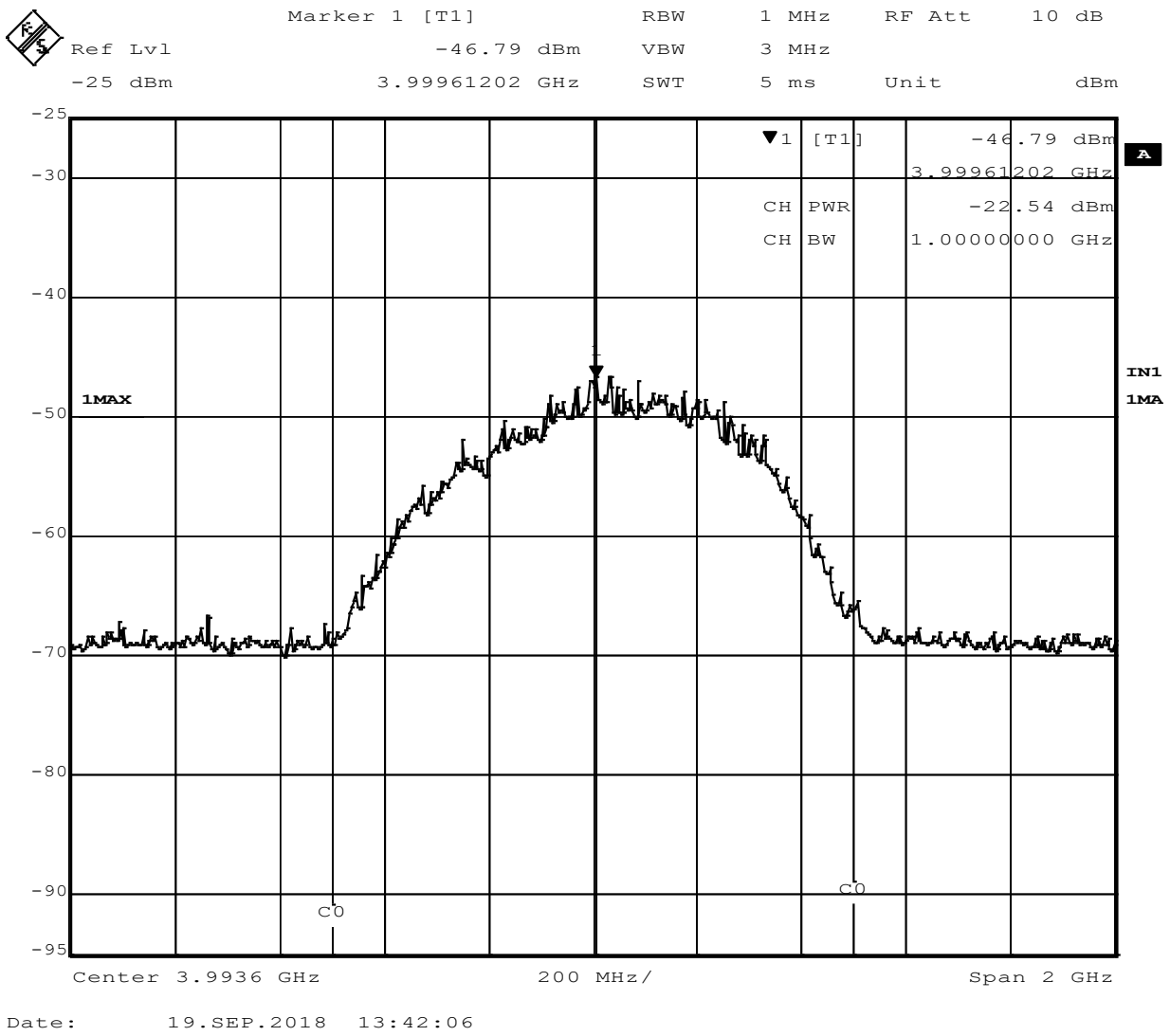

Figure 10 – Output Power, Low Channel

*Marker 1 represents peak. Ch power is just for reference.

Maximum Peak power = -46.79 dBm + 107 + CL + AF - 95.23-PA-DC = -48.03 dBm
PA=Preamp correction=32.10
DC=Duty cycle correction=23.09
CL = cable loss = 9.7 dB
AF = antenna factor = 32.48 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, Section(s) 10.1

Limits of bandwidth measurements:
For Informational purposes only

Test procedures:

The 10 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 10dB.

Deviations from test standard:
No deviation.

Test setup:

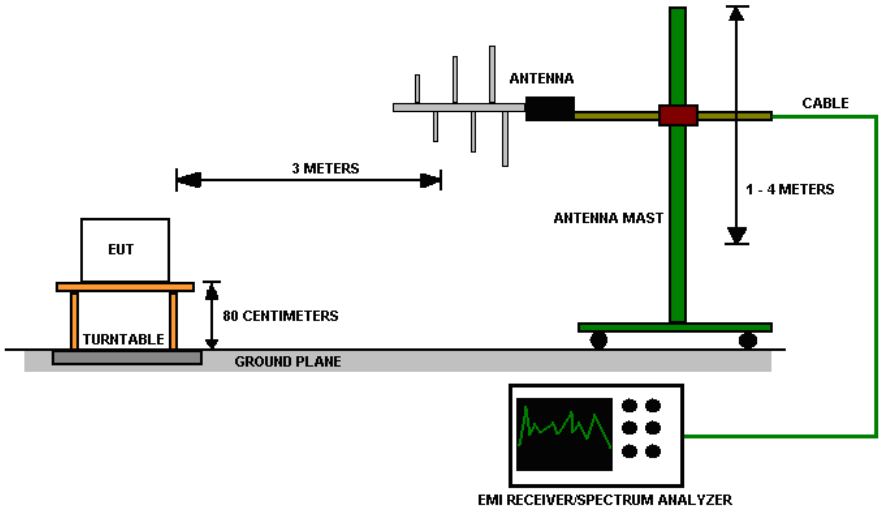

Figure 11 - Bandwidth Measurements Test Setup

EUT operating conditions:
The EUT was powered by 7.4 VDC unless specified and set to transmit continuously.

Test results:

10 dB Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	10 dB BW (MHz)
1	3993.6	645.29

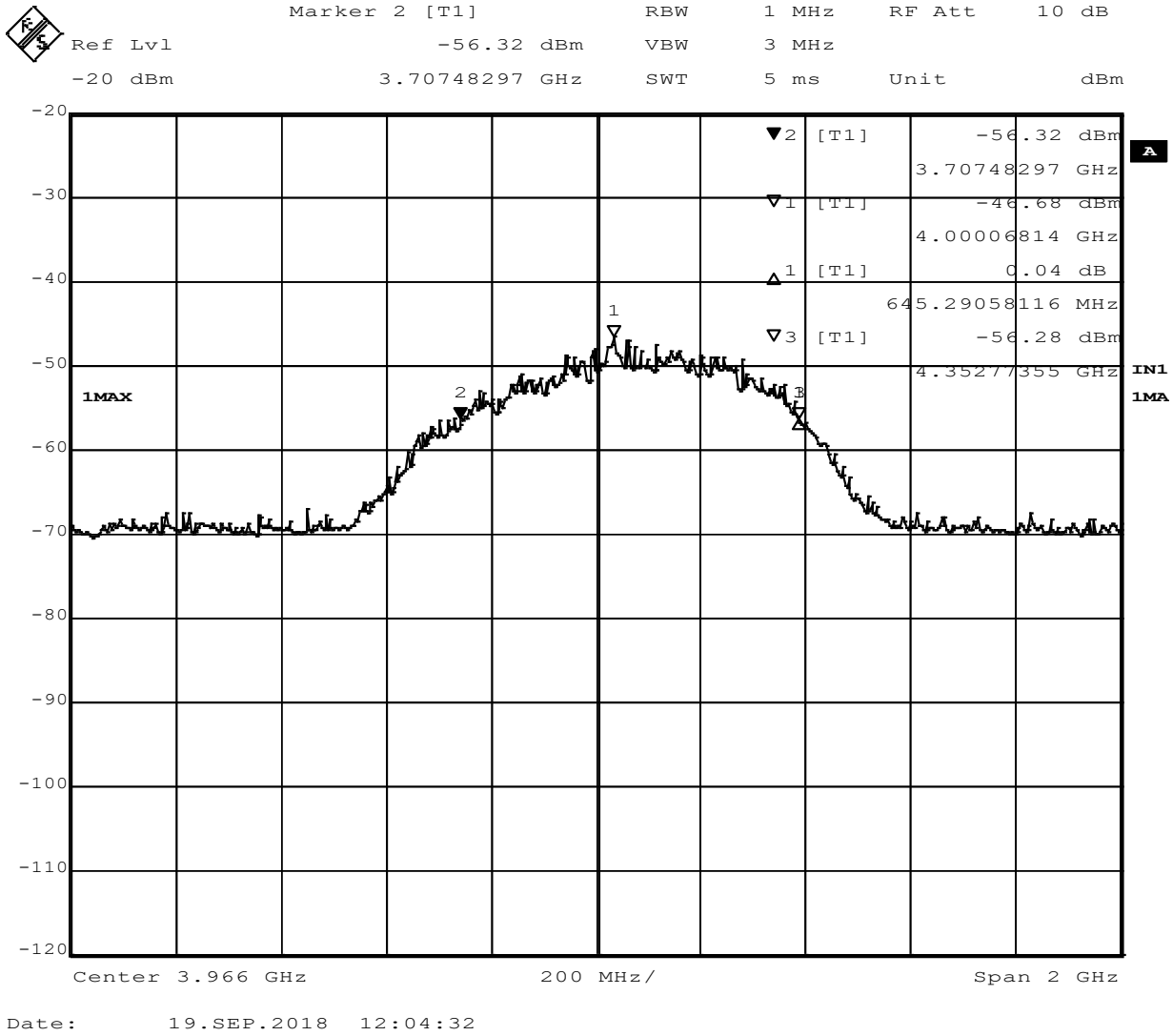

Figure 12 – 10 dB Bandwidth

All emissions are contained within 31000 to 10600 MHz as required by Part 15.519(b)

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