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FCC/ISED Test Report

Prepared for: **Digital Monitoring Products**

Address: **2500 North Partnership Blvd.**
Springfield, MO 6582

Product: **1108**

Test Report No: **R20190515-20A**

Approved by:

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

DATE: **10 July 2019**

Total Pages: **51**

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TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	27 June 2019	Original – NJohnson Prepared by KVepuri/CJacobson
A	10 July 2019	Measured receive mode emissions and added conducted emissions margins. Added note about channel occupancy to Section 4.6. Includes NCEE Labs repot R20190515-20 and its amendment in full.

CONTENTS

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

SUMMARY			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
FCC 15.203	Unique Antenna Requirement	Pass	PCB antenna
FCC 15.35 RSS-Gen, 6.10	Duty cycle of pulsed emissions	Informative only	Duty cycle was applied
FCC 15.209 RSS-Gen, 7.1	Receiver Radiated Emissions	Pass	Meets the requirement of the limit.
FCC 15.247(a)(1)(i) RSS-247, 5.1(c)	Minimum Bandwidth, Limit: Min. 250kHz	Pass	Meets the requirement of the limit.
FCC 15.247(b)(1) RSS-247, 5.1	Maximum Peak Output Power, Limit: Max. 24 dBm	Pass	Meets the requirement of the limit.
FCC 15.209 RSS-Gen, 8.9 RSS-247, 5.5	Transmitter Radiated Emissions	Pass	Meets the requirement of the limit.
FCC 15.247(a) (1) (i) RSS-247, 5.1(c)	Frequency hopping system, Limit: Max. 0.4 Seconds in 20 Second Period	Pass	Meets the requirement of the limit.
FCC 15.209, 15.205 RSS-Gen, 8.9 RSS-247, 5.5	Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency	Pass	Meets the requirement of the limit.
FCC 15.207 RSS-Gen. 8.8	Conducted AC Emissions	NA	EUT runs on a replaceable, non-rechargeable battery

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary

The Equipment Under Test (EUT) was 1108 a Wireless transmitter manufactured by DMP wireless devices. It operates in the 902 to 928 MHz ISM band and has transmit and receive capabilities.

EUT	1108
EUT Received	6/5/2019
EUT Tested	6/5/2019 - 6/25/2019 7/10/2019 (receive mode testing)
Serial No.	NCEEETEST1 (Assigned)
Operating Band	902 – 928 MHz
Device Type	FHSS
Power Supply	TRIAD Model: WS2U120-0700 Input: 100-240V, 50/60Hz, .4A Output: 12V,0.7A
Antenna	1.0 dBi (Gain) - PCB trace

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	905.6
Middle	915.0
High	924.4

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

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	Nic Johnson	Technical Manager	Review of Results
2	Karthik Vepuri	EMC Test Engineer	Testing and Report
3	Fox Lane	EMC Test Technician	Testing and Report

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 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*
Rohde & Schwarz LISN	ESH3-Z5	836679/010	26 Jul 2018	26 Jul 2019
Rohde & Schwarz Test Software	ES-K1	12575	NA	NA
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

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

4.0 DETAILED RESULTS

4.1 DUTY CYCLE

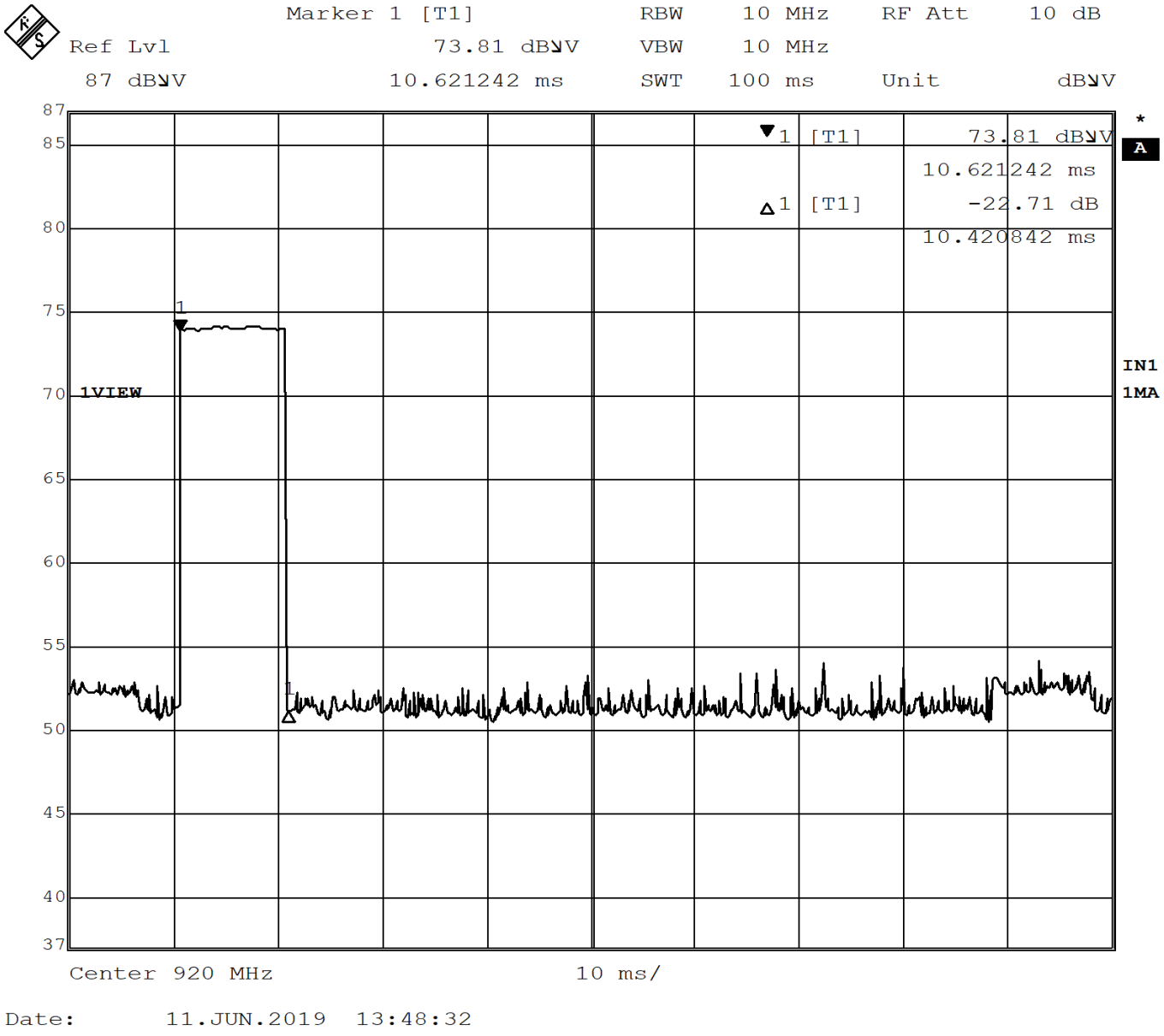

Figure 1 – On Time

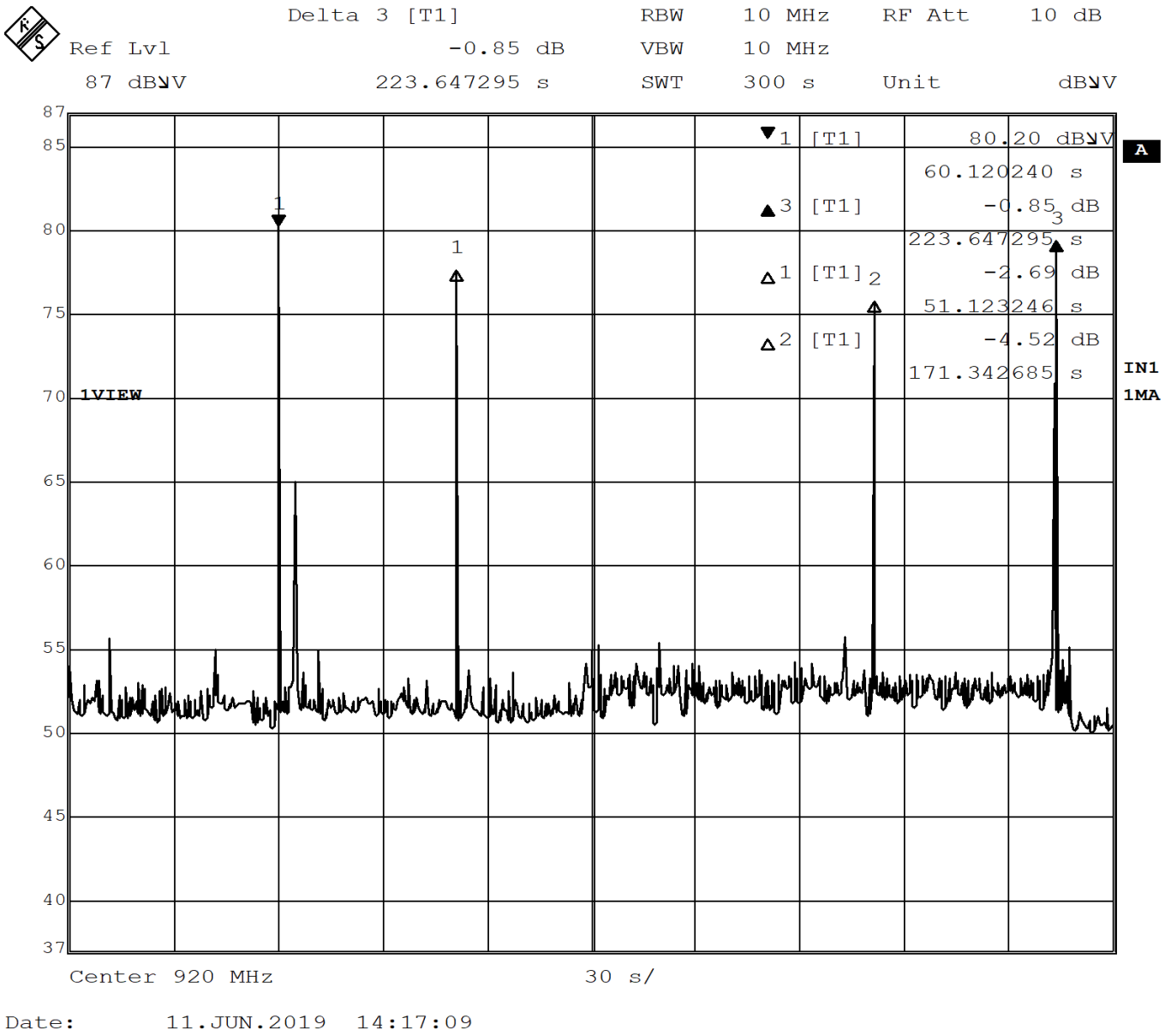

Figure 2 –Period

Maximum On time in 100 ms window = 10.42ms

Duty cycle correction factor = 20*log((10.42)/100) = -19.64 dB

The duty-cycle is based on dwell time on a single channel and total transmit time in a 100ms period. Each transmission is achieved in 1 hop cycle and it cannot transmit more than 1 time per 100ms period.

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.

h. The orientation with the worst-case emissions was used for final measurements.

i. Receive mode emissions were tested and found to be within the measurement noise floor of the test laboratory

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:

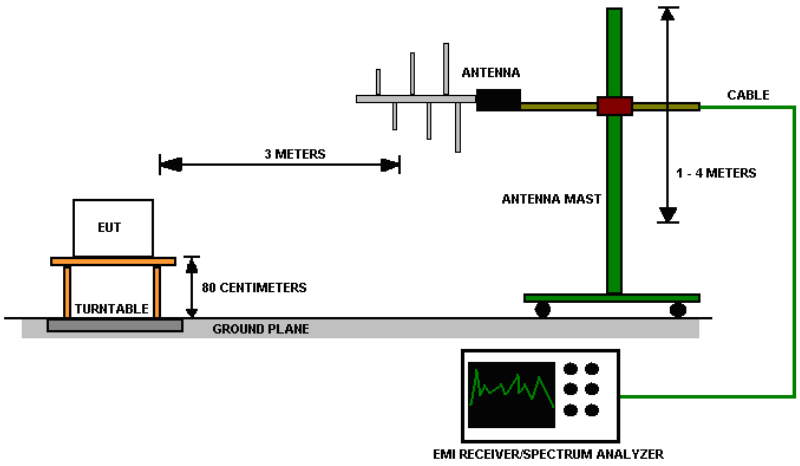

Figure 3 - Radiated Emissions Test Setup

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.

Test results:

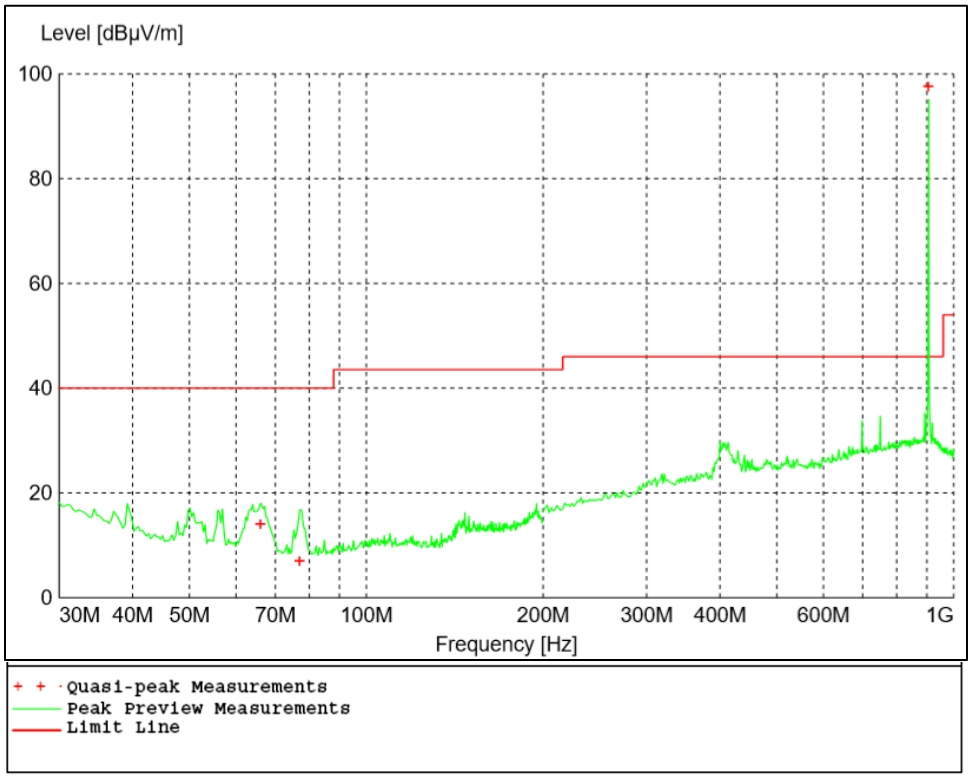

Figure 4 - Radiated Emissions Plot, 30 MHz-1 GHz Low Channel

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 both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

Table 1 - Radiated Emissions Quasi-peak Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
66.000000	14.04	40.00	26.00	123	65	VERT
76.980000	6.96	40.00	33.00	400	292	VERT
905.600000	97.57	NA	NA	123	0	HORI

Table 2 - Radiated Emissions Average Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1811.200000	41.39	54.00	12.61	123	329	HORI
2716.800000	22.55	54.00	31.45	143	351	HORI
3622.400000	34.29	54.00	19.71	136	329	HORI
4528.000000	22.21	54.00	31.79	160	46	HORI
5433.400000	22.26	54.00	31.74	100	360	VERT
6339.200000	23.55	54.00	30.45	192	2	HORI
7244.600000	41.17	54.00	12.83	100	62	HORI
9055.600000	39.32	54.00	14.68	99	129	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case (X axis) is shown in the table above.
Average Level = Peak Level – 19.64(Duty Cycle Correction Factor)

Table 3 - Radiated Emissions Peak Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1811.200000	61.03	74.00	12.97	123	329	HORI
2716.800000	42.19	74.00	31.81	143	351	HORI
3622.400000	53.93	74.00	20.07	136	329	HORI
4528.000000	41.85	74.00	32.15	160	46	HORI
5433.400000	41.90	74.00	32.10	100	360	VERT
6339.200000	43.19	74.00	30.81	192	2	HORI
7244.600000	60.81	74.00	13.19	100	62	HORI
9055.600000	58.96	74.00	15.04	99	129	HORI

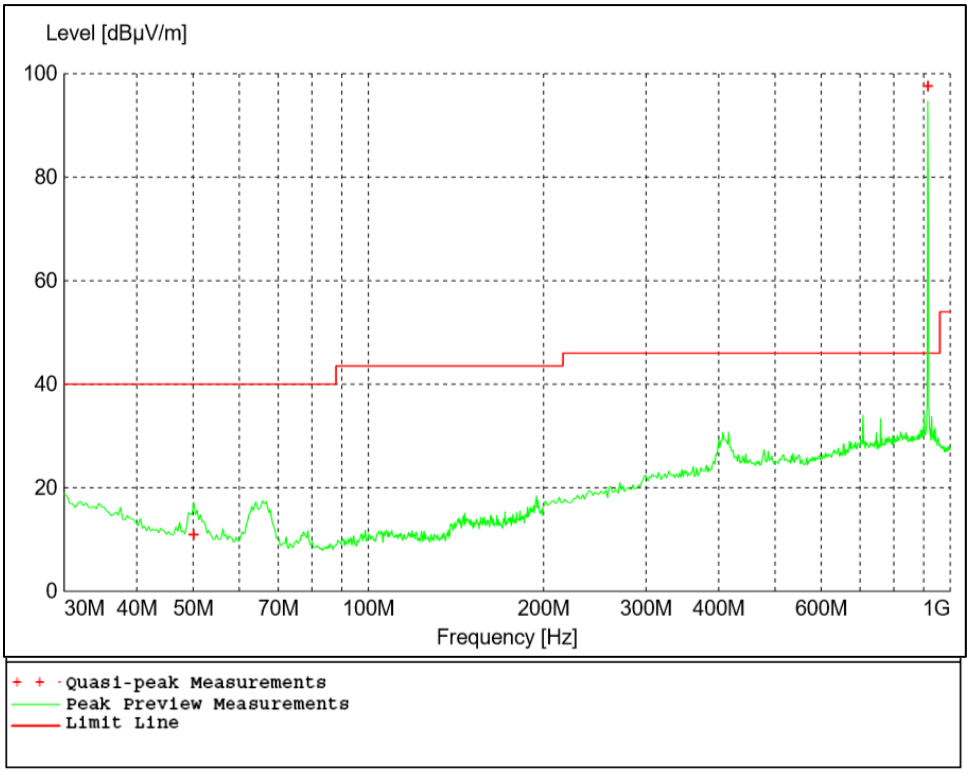

Figure 5 - Radiated Emissions Plot, 30 MHz-1 GHz Mid Channel

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 both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

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

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
50.040000	10.84	40.00	29.20	100	105	VERT
915.000000	97.53	NA	NA	115	0	HORI

Table 5 - Radiated Emissions Average Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1830.000000	41.97	54.00	12.03	123	210	HORI
2745.000000	23.82	54.00	30.18	194	286	HORI
3660.000000	35.03	54.00	18.97	100	239	HORI
4575.000000	23.29	54.00	30.71	376	0	HORI
5490.000000	20.74	54.00	33.26	100	334	VERT
6405.000000	31.96	54.00	22.04	100	129	VERT
7320.000000	40.63	54.00	13.37	99	214	HORI
8234.800000	33.38	54.00	20.62	100	79	VERT
9150.000000	37.10	54.00	16.90	100	25	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case (X axis) is shown in the table above.
Average Level = Peak Level – 19.64(Duty Cycle Correction Factor)

Table 6 - Radiated Emissions Peak Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1830.000000	61.61	74.00	12.39	123	210	HORI
2745.000000	43.46	74.00	30.54	194	286	HORI
3660.000000	54.67	74.00	19.33	100	239	HORI
4575.000000	42.93	74.00	31.07	376	0	HORI
5490.000000	40.38	74.00	33.62	100	334	VERT
6405.000000	51.60	74.00	22.40	100	129	VERT
7320.000000	60.27	74.00	13.73	99	214	HORI
8234.800000	53.02	74.00	20.98	100	79	VERT
9150.000000	56.74	74.00	17.26	100	25	VERT

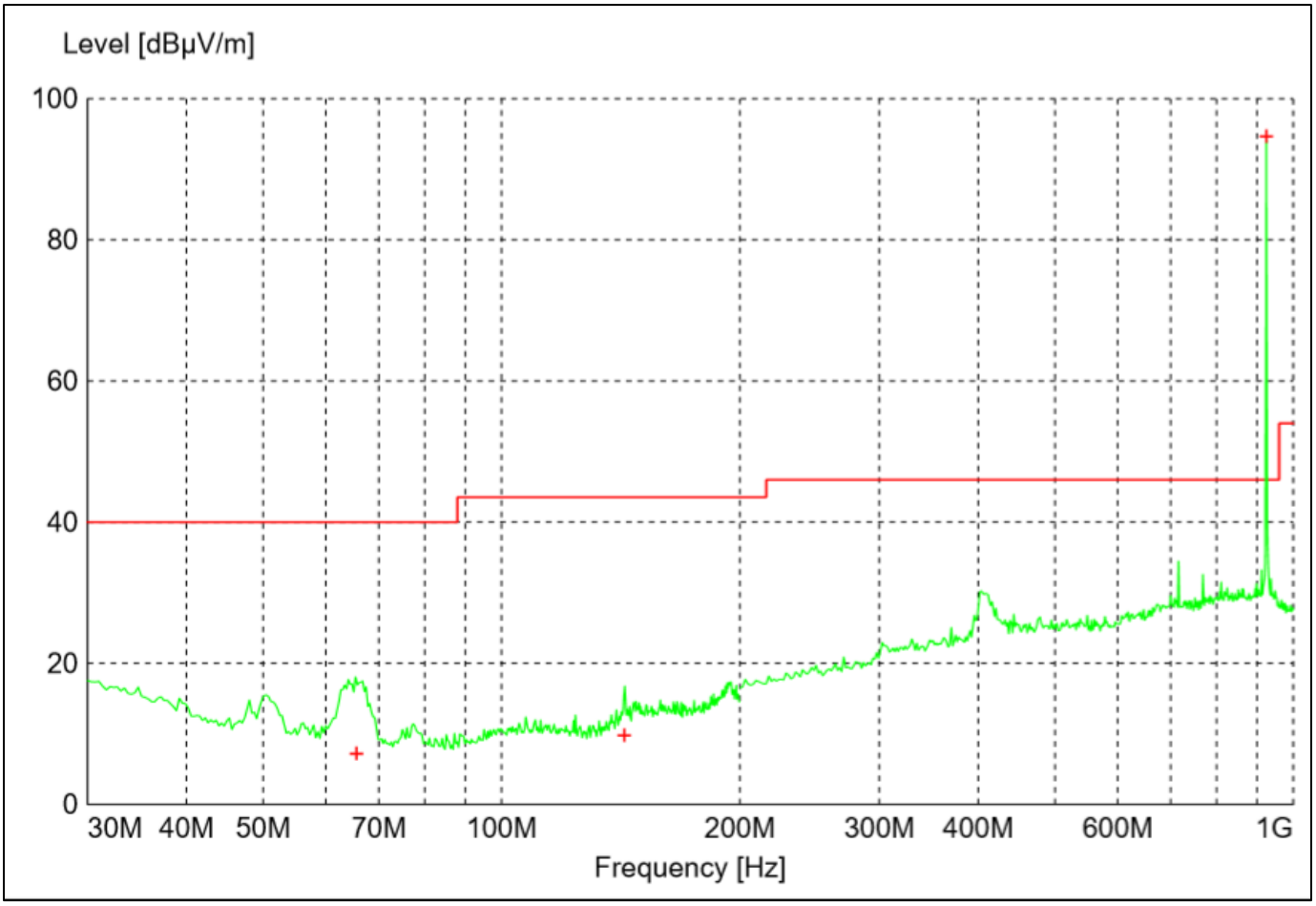

Figure 6 - Radiated Emissions Plot, 30 MHz-1 GHz High Channel

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 both the horizontal and vertical orientation. It was found that the Horizontal position produced the highest emissions, and this orientation was used for all testing. See Annex A for test photos.

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

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
65.580000	7.25	40.00	32.80	357	32	VERT
142.920000	9.79	43.50	33.70	100	302	VERT
924.400000	94.68	NA	NA	115	0	HORI

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

Table 8 - Radiated Emissions Average Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1848.800000	40.05	54.00	13.95	123	278	HORI
2773.200000	22.56	54.00	31.44	153	346	HORI
3697.600000	34.29	54.00	19.71	106	329	HORI
4622.000000	26.81	54.00	27.19	139	169	VERT
5546.200000	28.73	54.00	25.27	100	165	VERT
6471.000000	32.14	54.00	21.86	109	121	HORI
7395.400000	40.34	54.00	13.66	99	278	HORI
9243.800000	35.93	54.00	18.07	110	113	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case (X axis) is shown in the table above.
Average Level = Peak Level – 19.64(Duty Cycle Correction Factor)

Table 9 - Radiated Emissions Peak Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1848.800000	59.69	74.00	14.31	123	278	HORI
2773.200000	42.20	74.00	31.80	153	346	HORI
3697.600000	53.93	74.00	20.07	106	329	HORI
4622.000000	46.45	74.00	27.55	139	169	VERT
5546.200000	48.37	74.00	25.63	100	165	VERT
6471.000000	51.78	74.00	22.22	109	121	HORI
7395.400000	59.98	74.00	14.02	99	278	HORI
9243.800000	55.57	74.00	18.43	110	113	HORI

4.3 PEAK OUTPUT POWER

Test Method: ANSI C63.10, Section(s) 7.8.5

Limits of bandwidth measurements:
For an FHSS system with 25 channels, the output power is required to be less than 250 mW or 24 dBm.

EIRP was calculated from field strength measurements using ANSI C63.10:2013, Section 9.5, Equation (22). The field strength was measured at a 3m distance and maximized.

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

The EUT was maximized in all 3 orthogonal positions in a similar manner as described in Section 4.2.

Deviations from test standard:
No deviation.

Test setup:

See Section 4.2

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:

Peak Output Power

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK OUTPUT POWER EIRP (dBm)	PEAK OUTPUT POWER CONDUCTED** (dBm)	RESULT
Low	905.6	2.46	1.46	PASS
Middle	915.0	1.37	0.37	PASS
High	924.4	-0.41	-1.41	PASS

*Measurements were performed as EIRP because there were no provisions for making conducted measurements.

**Based on EIRP – antenna gain calculation

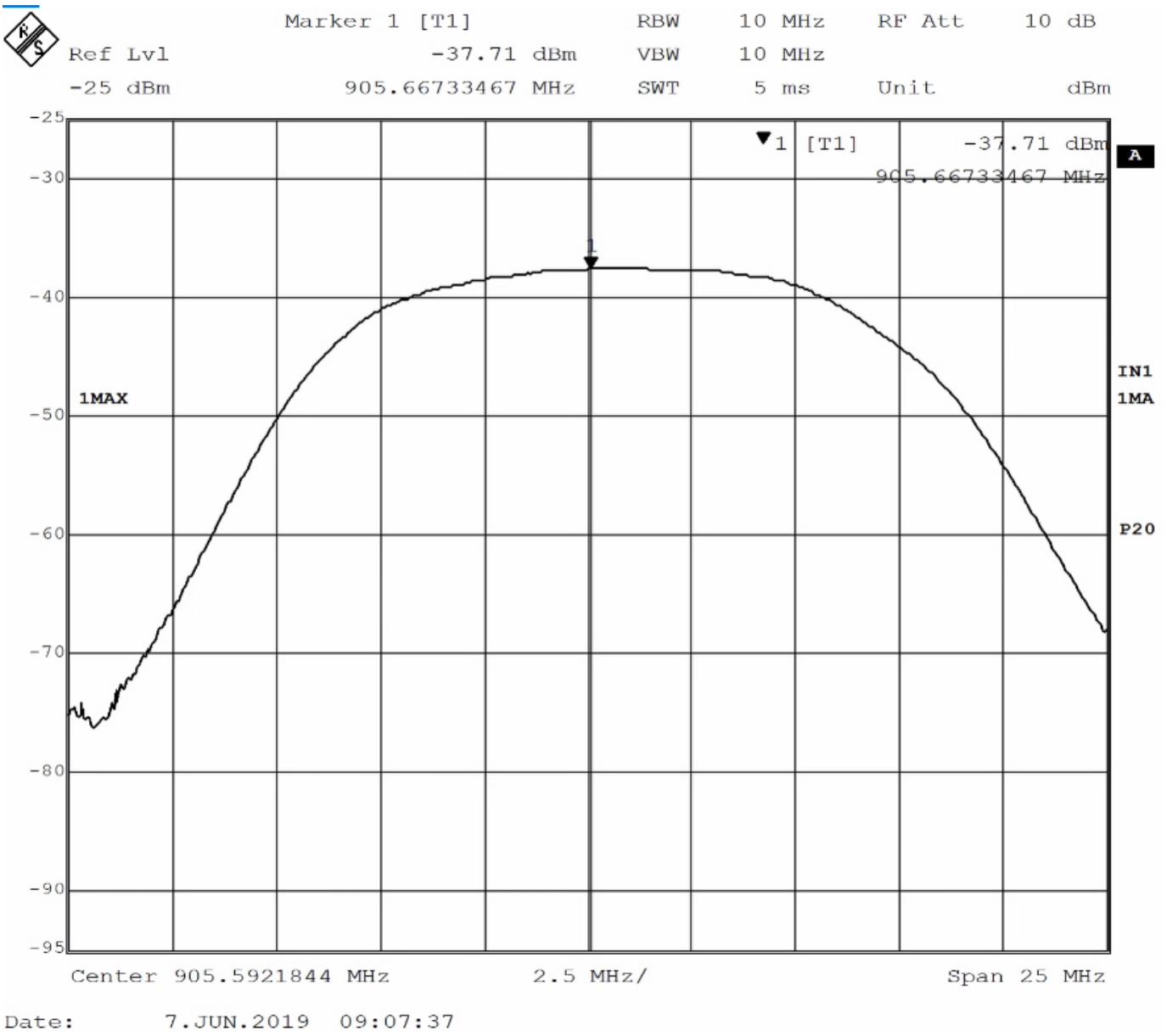

Figure 7 – Output Power, Low Channel.

Maximum power = -37.71 dBm + 107 + CL + AF - 95.23 = 2.46 dBm*

CL = cable loss = 4.80 dB

AF = antenna factor = 23.60 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

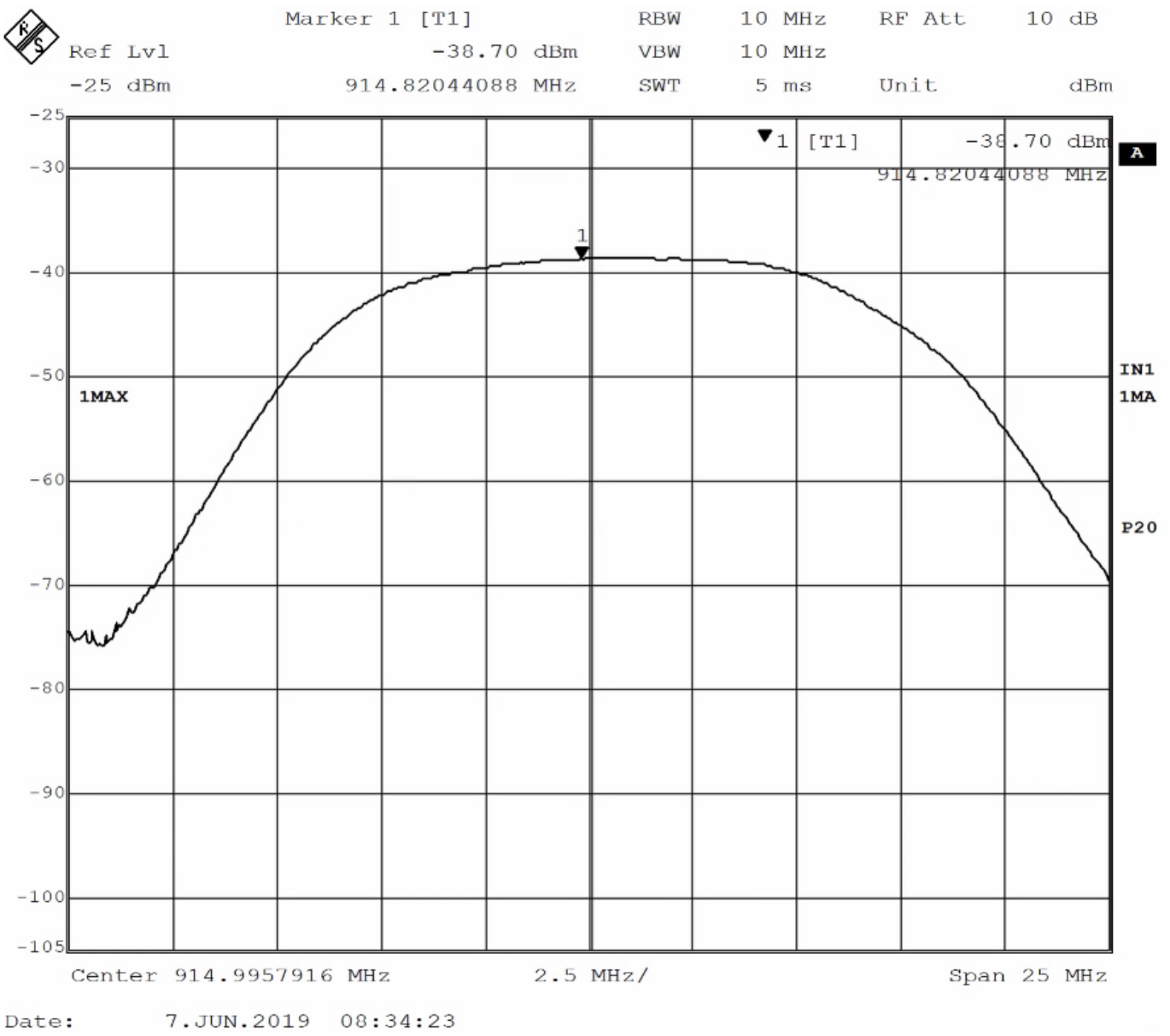

Figure 8 – Output Power, Mid Channel

Maximum power = -38.70 dBm + 107 + CL + AF - 95.23 = 1.37 dBm*

CL = cable loss = 4.80 dB

AF = antenna factor = 23.50 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.

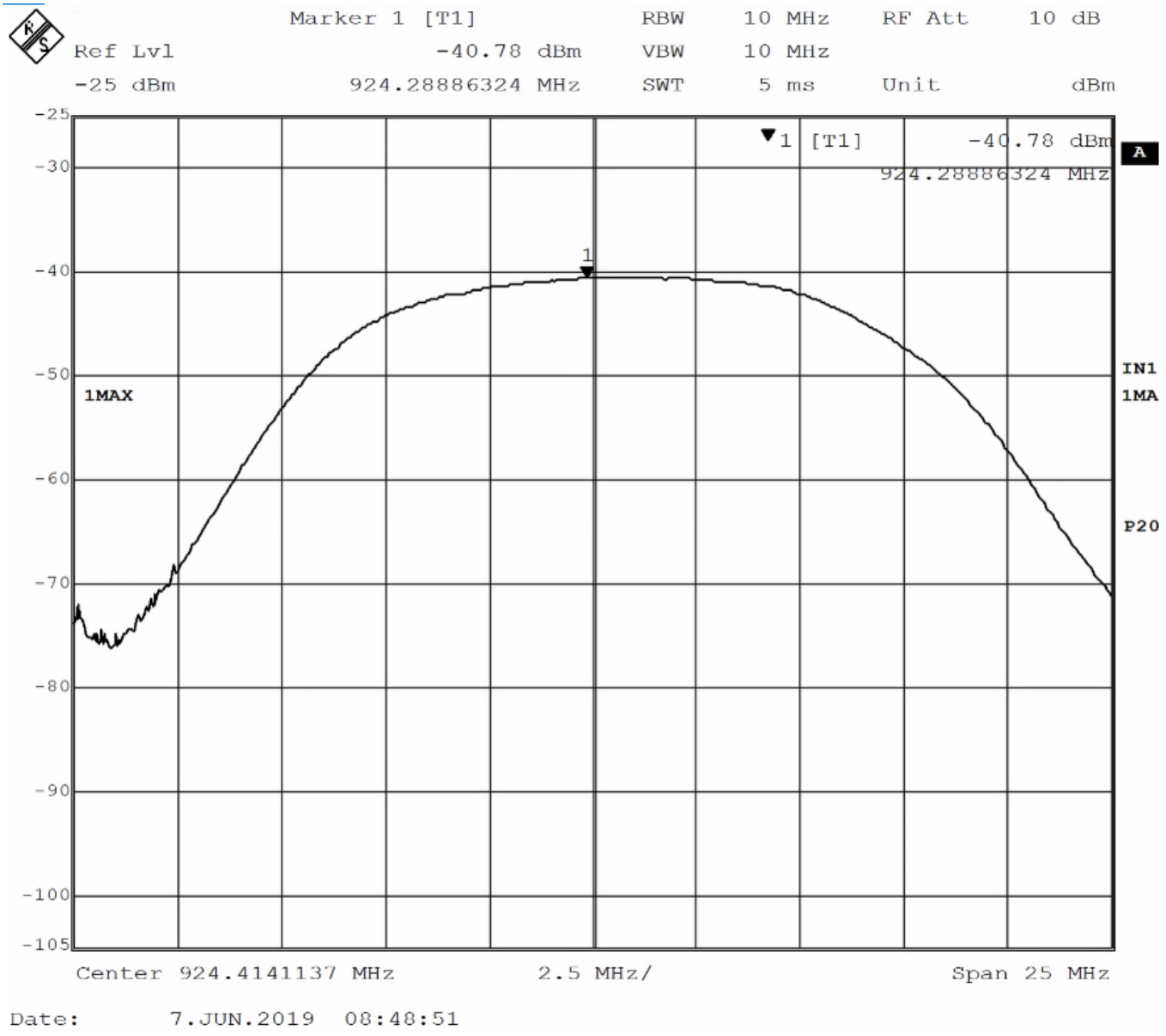

Figure 9 – Output Power, High Channel

Maximum power = -40.78 dBm + 107 + CL + AF - 95.23 = -0.41 dBm*

CL = cable loss = 4.80 dB

AF = antenna factor = 23.80 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) 6.9.2 (20 dB BW)
ANSI C63.10, Section(s) 6.9.3 (99% BW)

Limits of bandwidth measurements:
From FCC Part 15.247 (1) (i) and RSS-247 5.1(c)

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test procedures:
Bandwidth measurement was taken at a distance of 3m from the EUT. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 3 kHz RBW and 10 kHz VBW.

The 20dB bandwidth is defined as the bandwidth of which is higher than peak power minus 20dB.

The 99% occupied bandwidth was measured using the test receiver's occupied bandwidth function.

Test setup:

All the measurements were done at 3m test distance while an operator was trying to activate the hopping sequence manually. See Section 4.3 for more details.

Deviations from test standard:
No deviation.

Test setup:

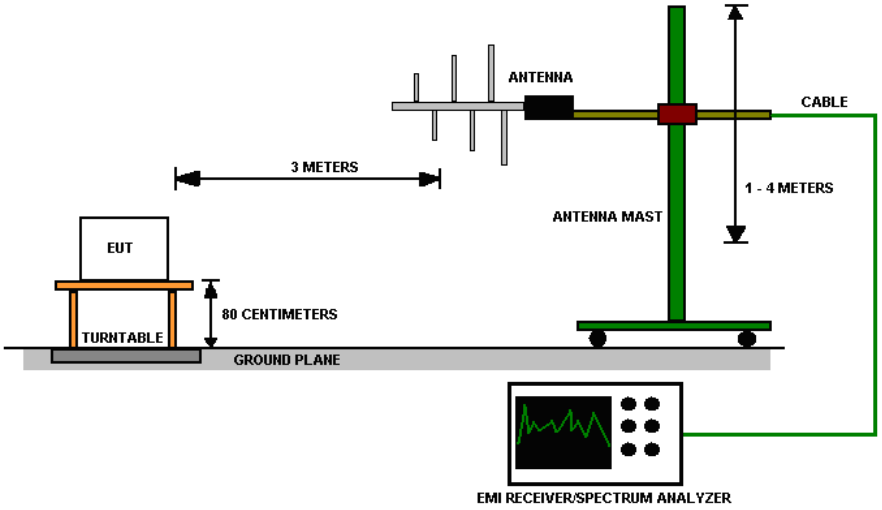

Figure 10 - Bandwidth Measurements Test Setup

EUT operating conditions:

The EUT was powered by 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:

Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	20dB BW (kHz)	99% Occupied Bandwidth (kHz)	RESULT
Low	905.6	72.54	81.36	PASS
Mid	914.7	73.75	84.17	PASS
High	924.4	71.74	80.56	PASS

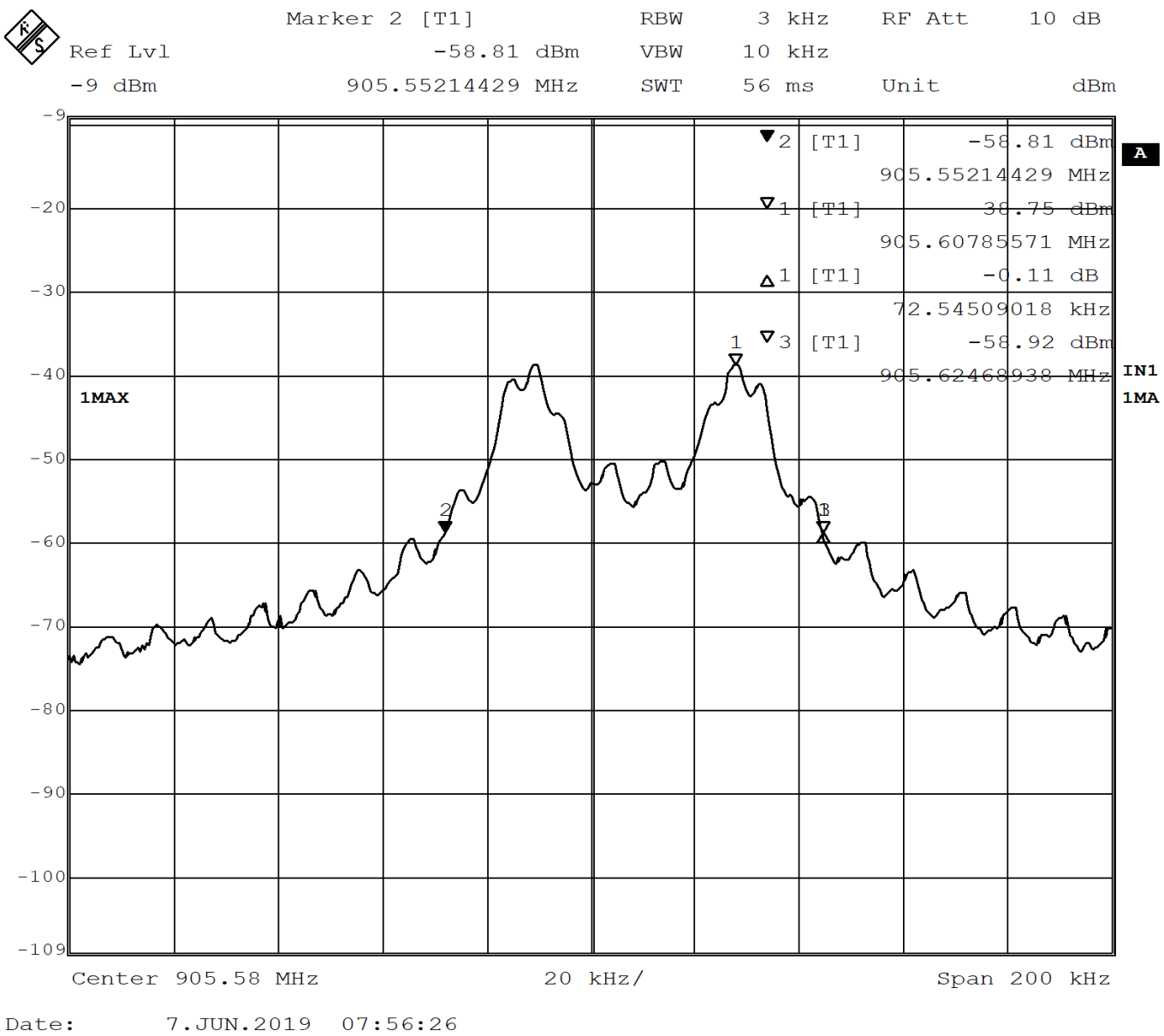

Figure 11 – 20 dB Bandwidth, Low Channel

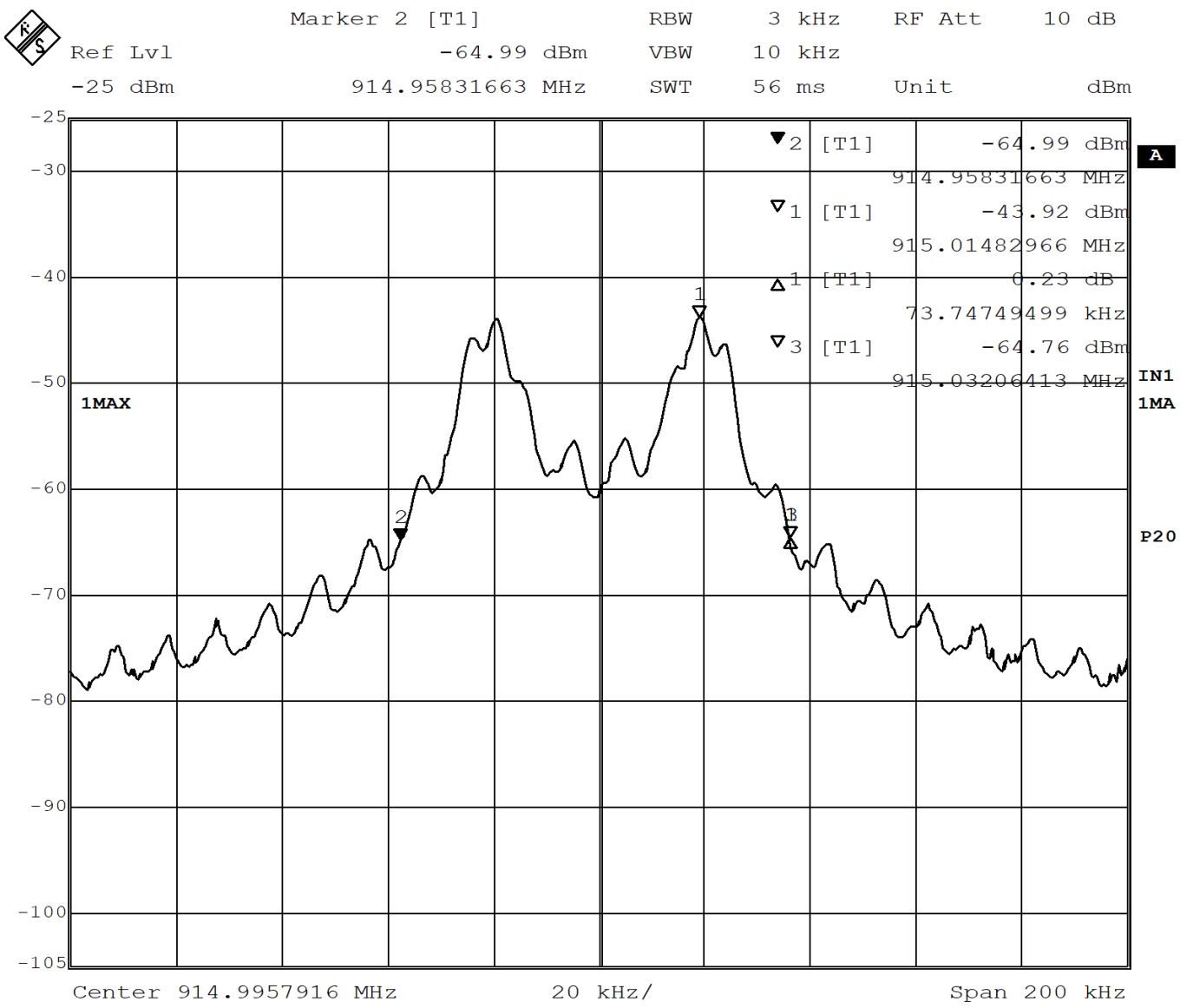

Figure 12 - 20 dB Bandwidth, Mid Channel

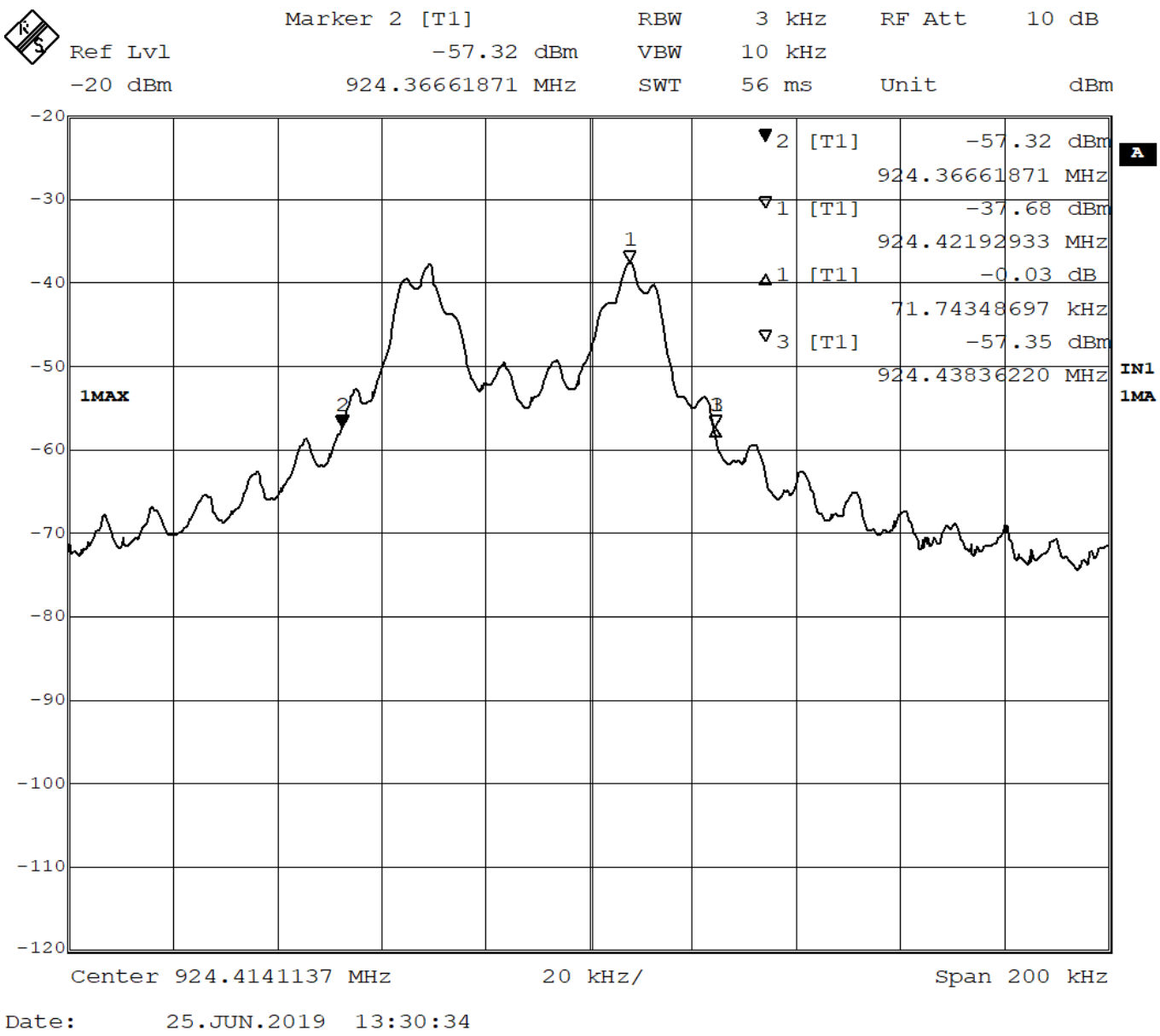

Figure 13 - 20 dB Bandwidth, High Channel

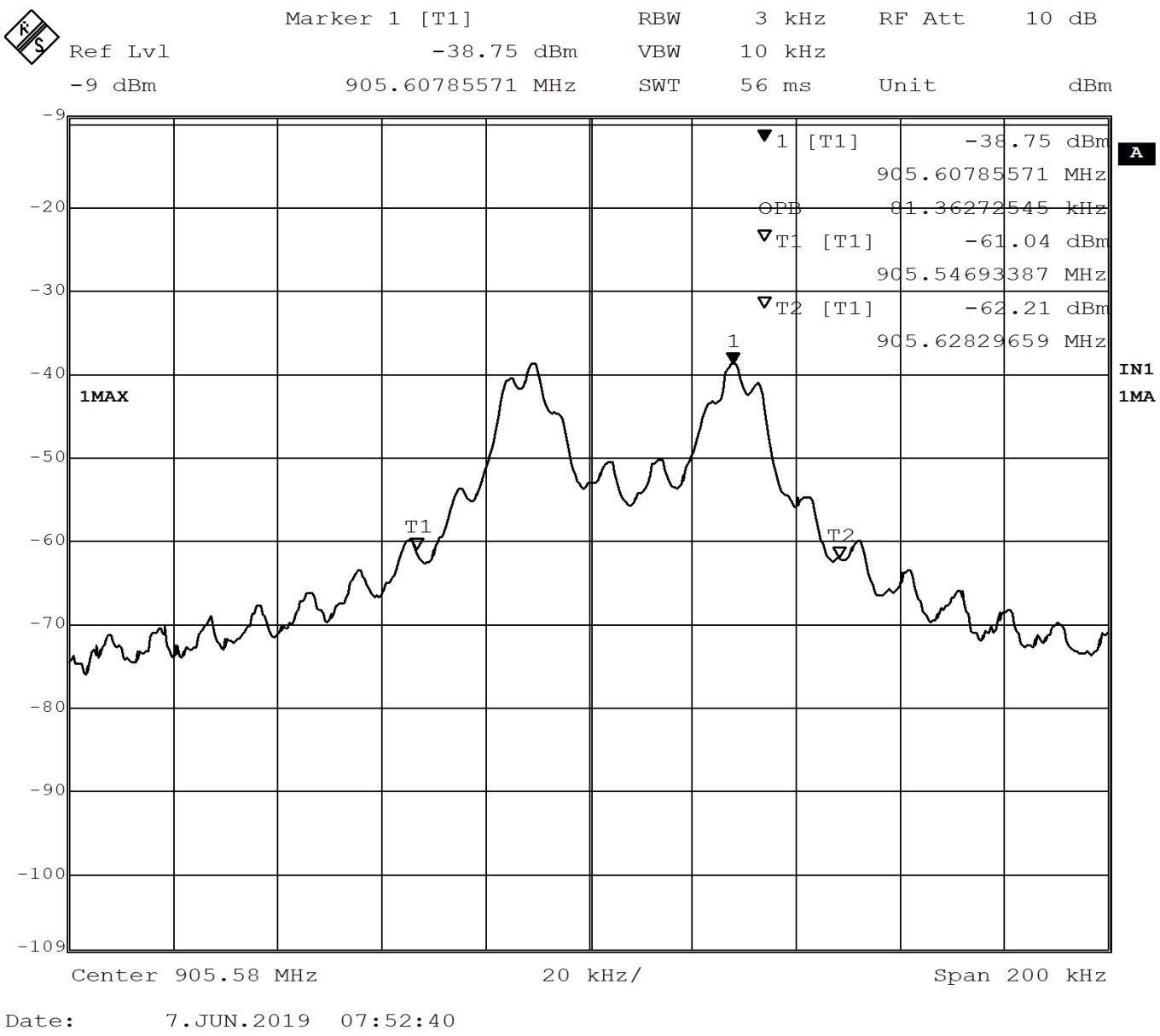

Figure 14 - 99% Occupied Bandwidth, Low Channel

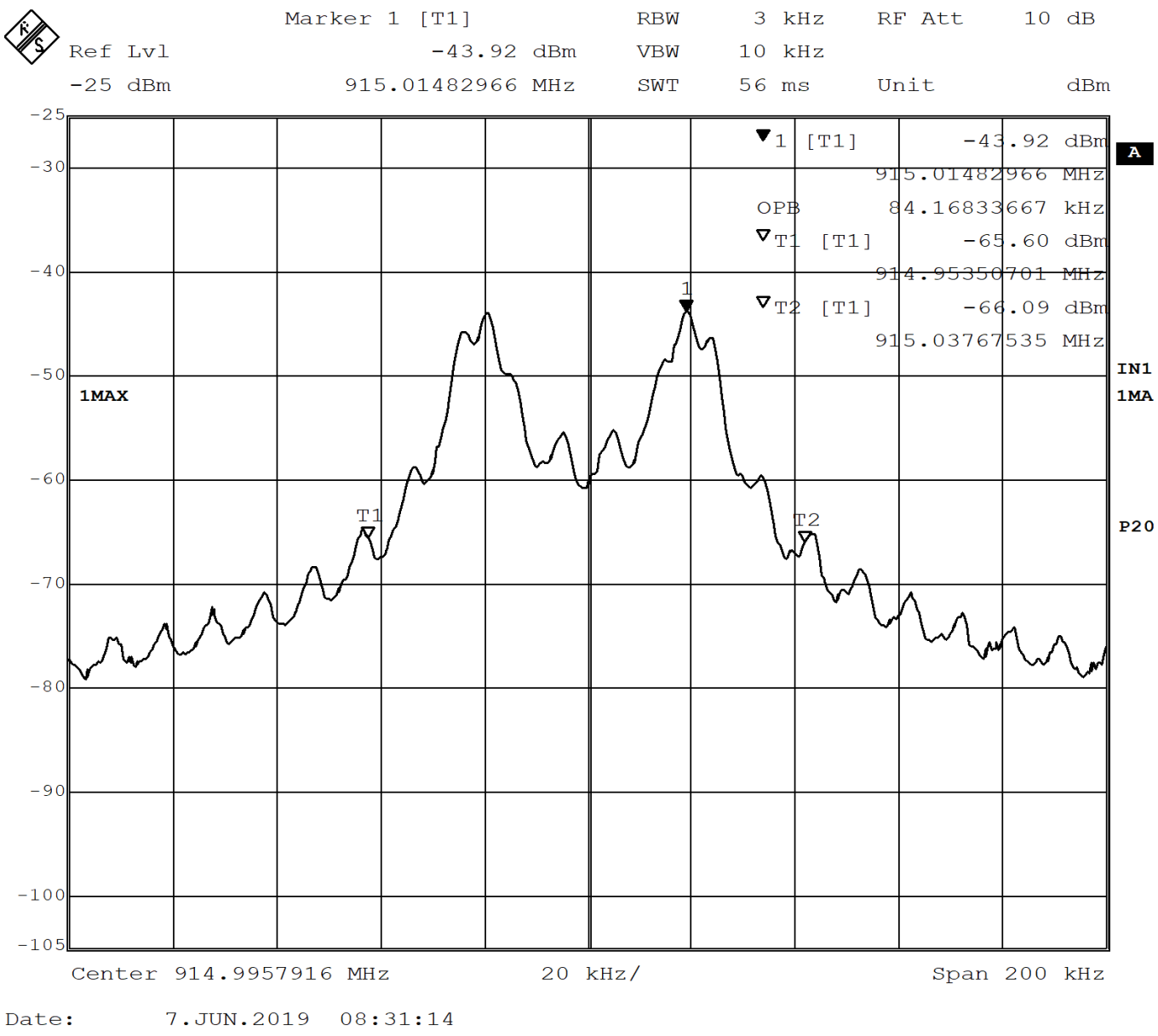

Figure 15 - 99% Occupied Bandwidth, Middle Channel

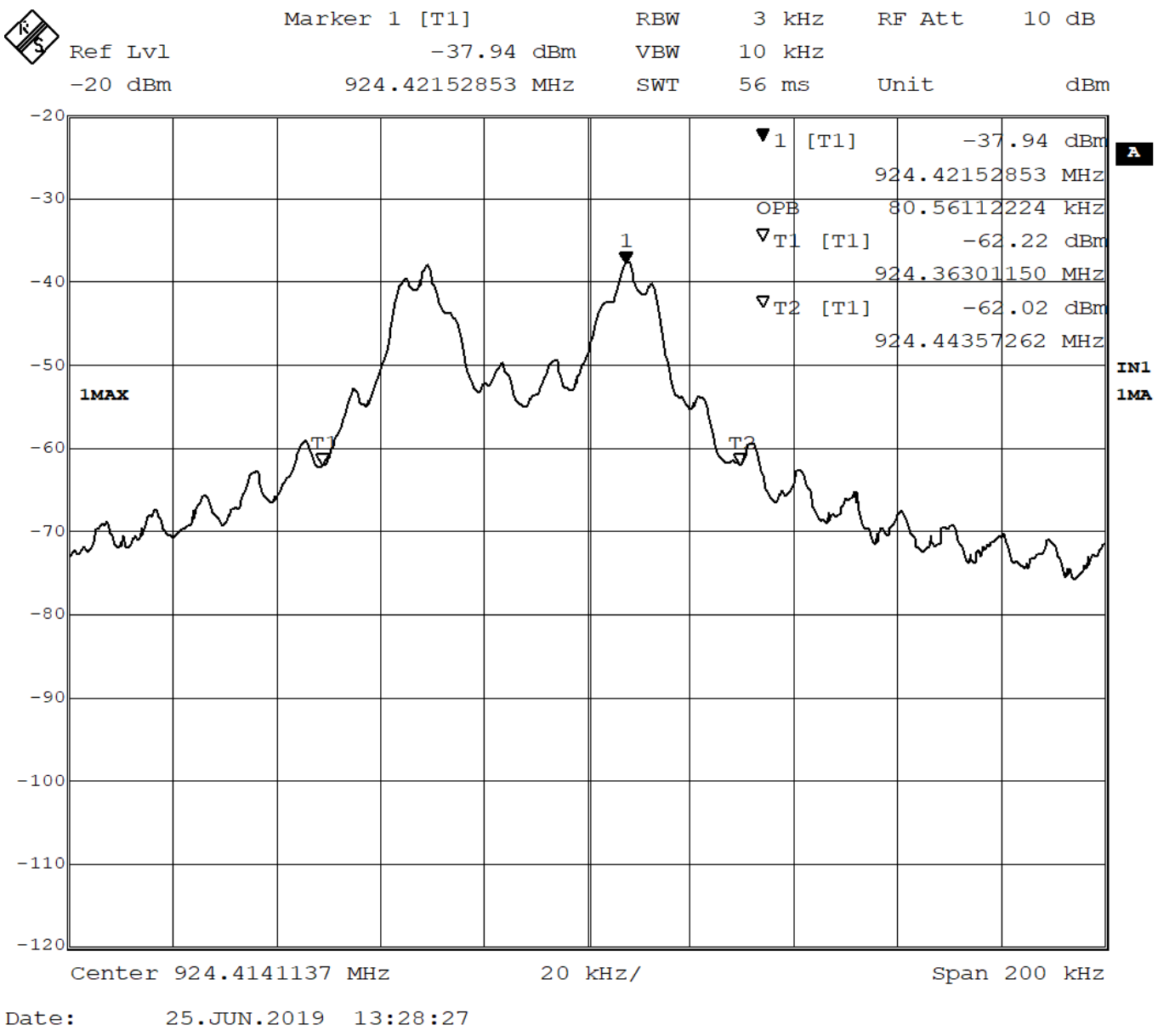

Figure 16 - 99% Occupied Bandwidth, High Channel

4.5 BANDEDGES

Test Method: ANSI C63.10, Section(s) 6.10.6

Limits of bandedge measurements:
For emissions outside of the allowed band of operation (902 – 928MHz), 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 30kHz 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.

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 12 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)	Relative Highest out of band level dBm	Relative Fundamental Level (dBm)	Delta	Min (dBc)	Result
Low, Continuous Restricted	614	-103.26	-33.71	69.55	51.57	PASS
Low Hopping Restricted	614	-104.66	-37.75	66.91	51.57	PASS
High, Continuous Restricted	960	-107.01	-40.86	66.15	48.68	PASS
High, Hopping Restricted	960	-107.14	-40.80	66.34	48.68	PASS
Low, Continuous Unrestricted	902	-78.81	-33.71	45.10	20.00	PASS
Low, Hopping Unrestricted	902	-95.41	-37.75	57.66	20.00	PASS
High, Continuous Unrestricted	928	-94.85	-40.86	53.99	20.00	PASS
High, Hopping Unrestricted	928	-98.55	-40.80	57.75	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 average field strength at 903.3 MHz for low channel = 97.57 dBµV/m
Fundamental average field strength at 926.6 MHz for high channel = 94.68 dBµV/m

Low channel minimum delta = 97.57 – 46.0 dBµV/m = 51.57 dBc
High channel minimum delta = 94.68 – 46.0 dBµV/m = 48.68 dBc

Measurements do not include correction factors and are intended to be relative measurements only.

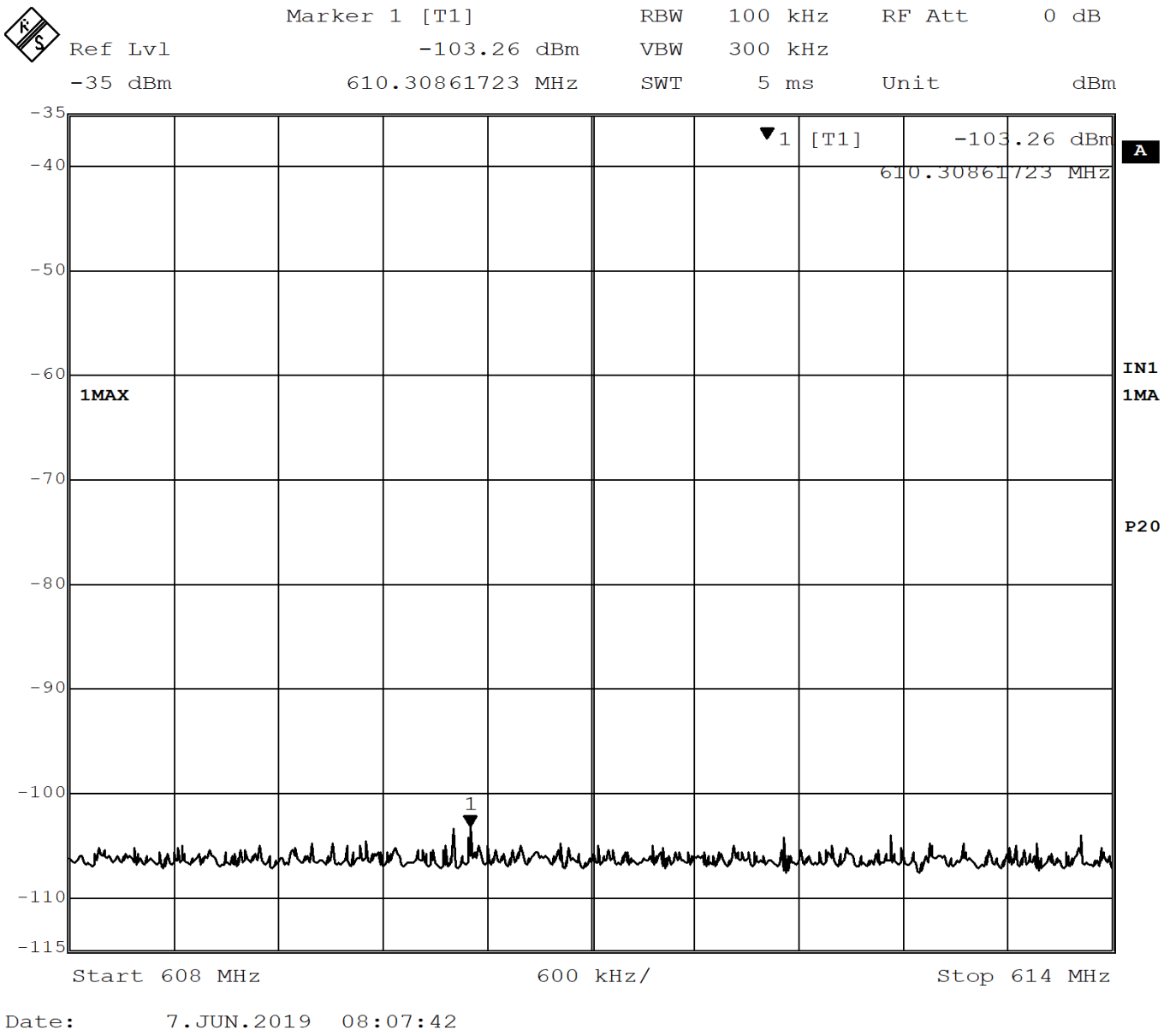

Figure 17 - Band-edge Measurement, Low Channel, Restricted Frequency, Continuous Transmit

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

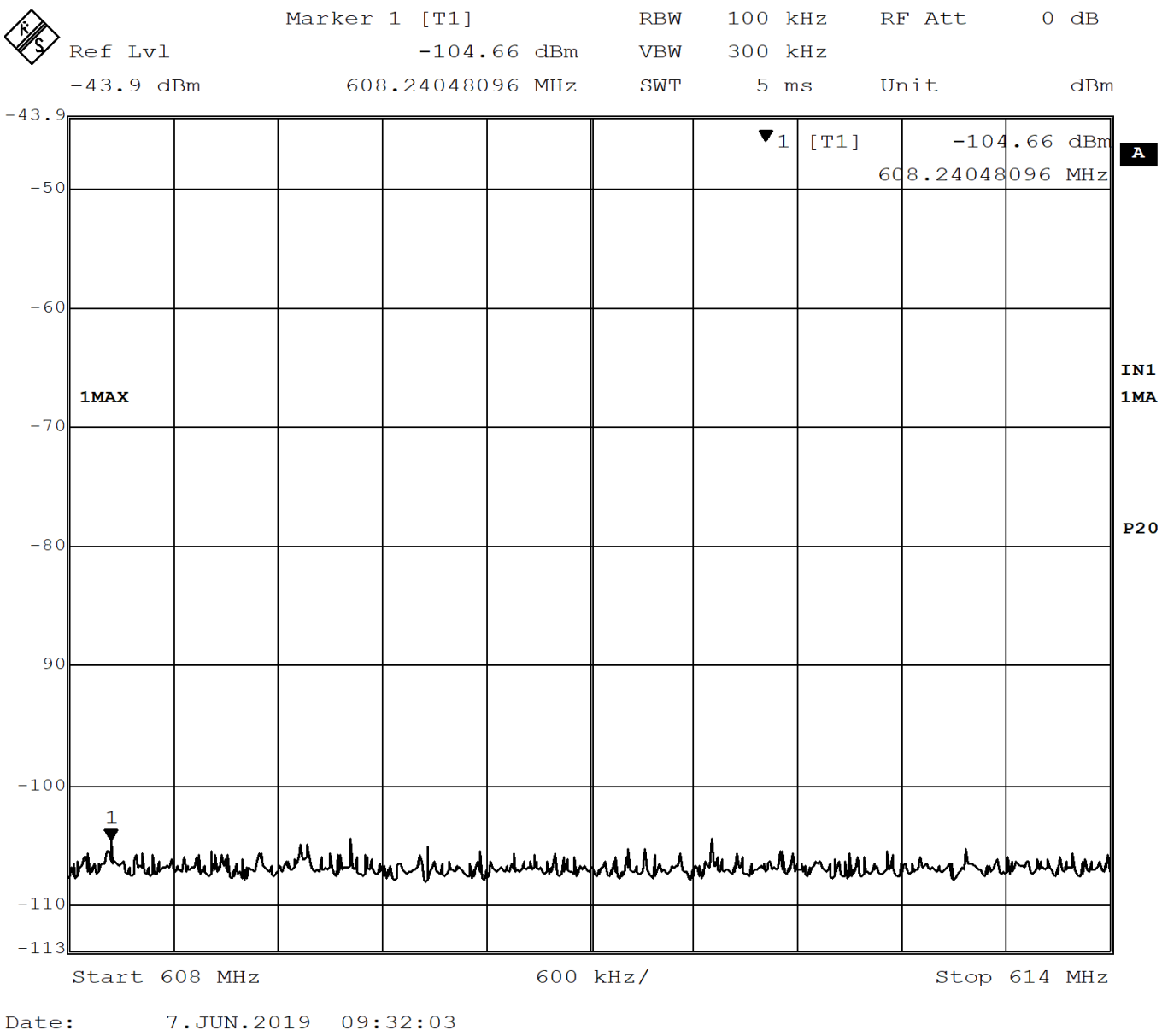

Figure 18 - Band-edge Measurement, Low Channel, Restricted Frequency, Hopping

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

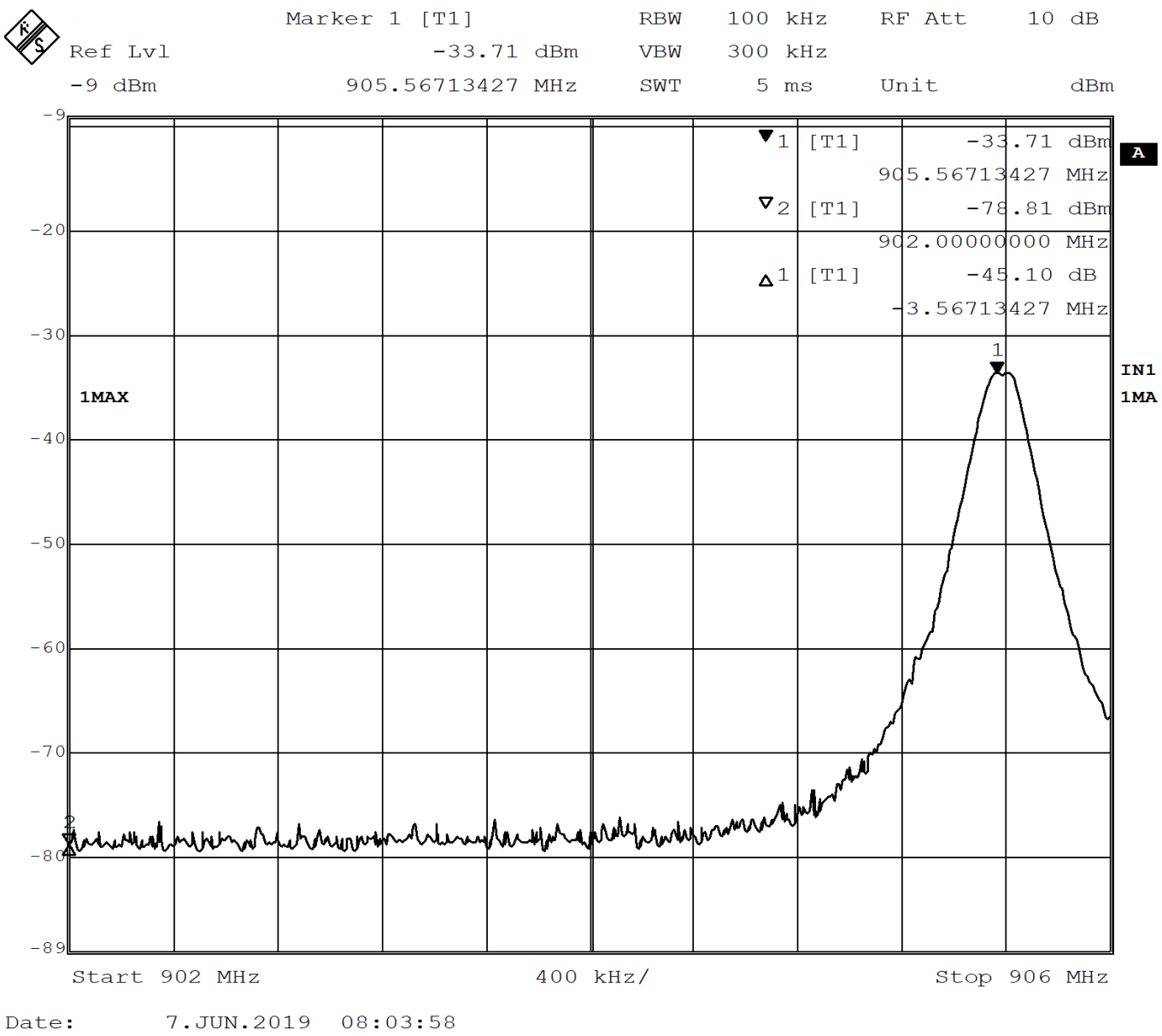

Figure 19 - Band-edge Measurement, Low Channel, Fundamental, Continuous Transmit

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

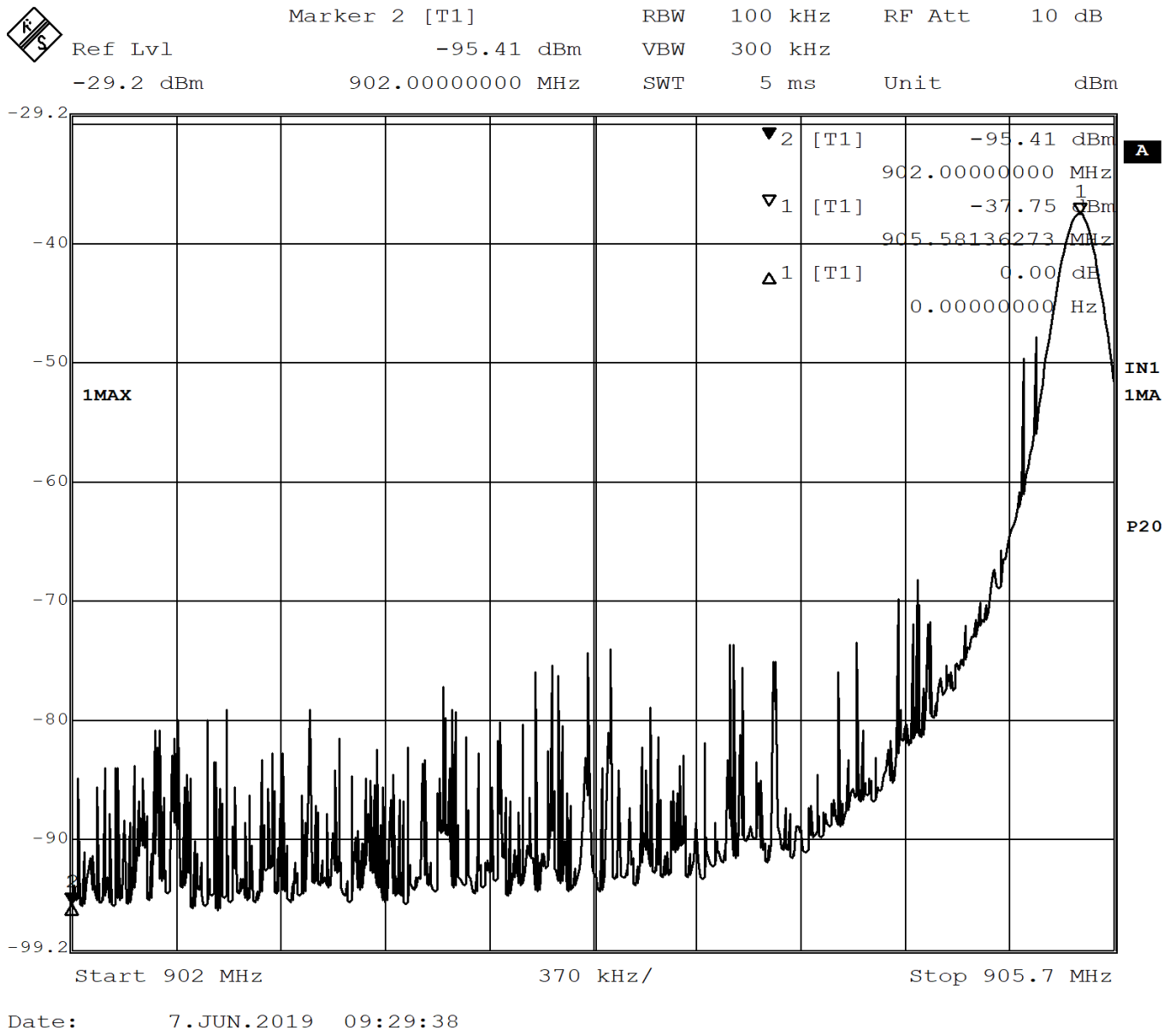

Figure 20 - Band-edge Measurement, Low Channel, Fundamental, Hopping Transmit

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

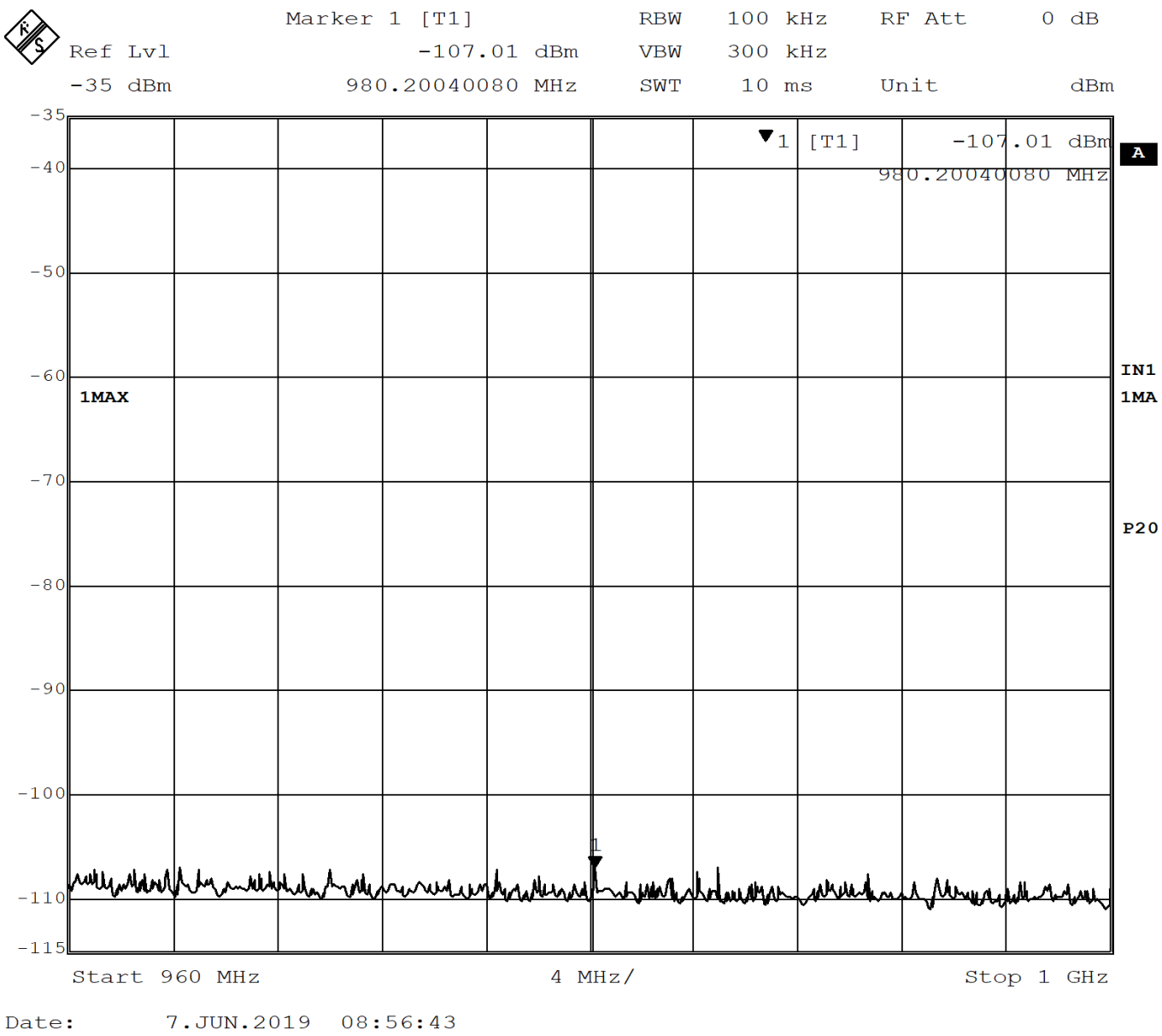

Figure 21 - Band-edge Measurement, High Channel, Restricted Frequency, Continuous Transmit

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

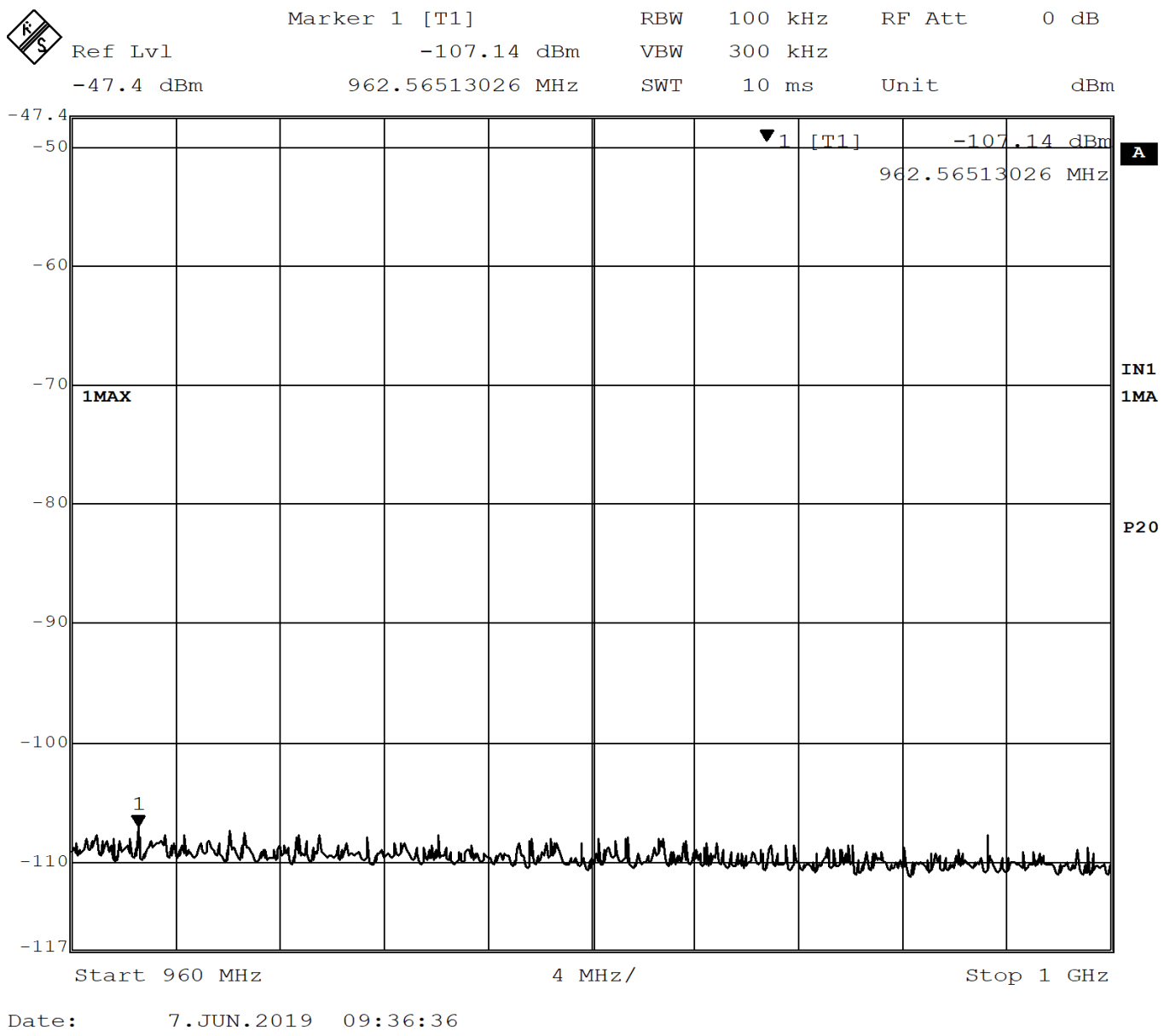

Figure 22 - Band-edge Measurement, High Channel, Restricted Frequency, Hopping

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

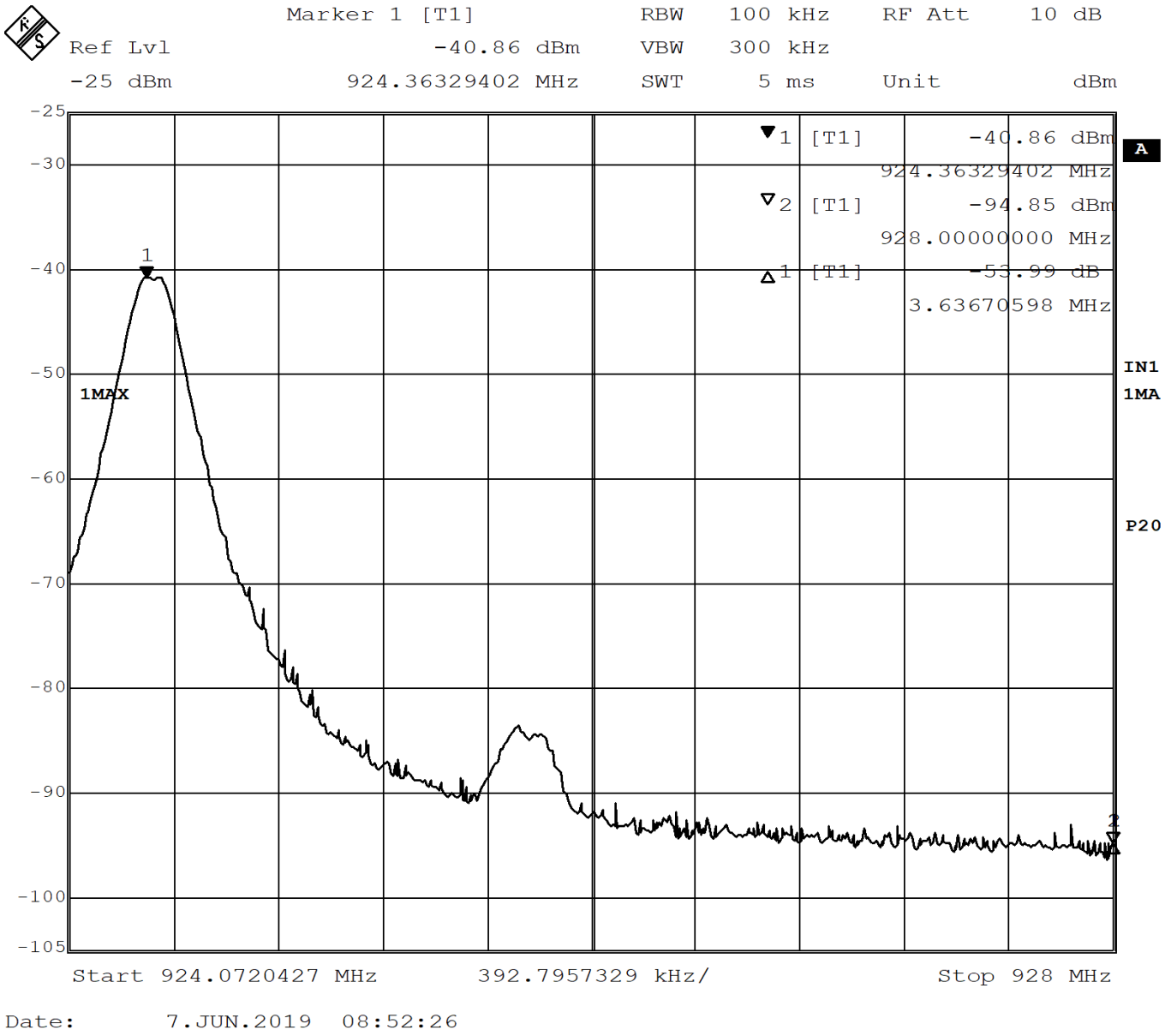

Figure 23 - Band-edge Measurement, High Channel, Fundamental, Continuous Transmit

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

Delta = 40.74 dB > 20 dB minimum

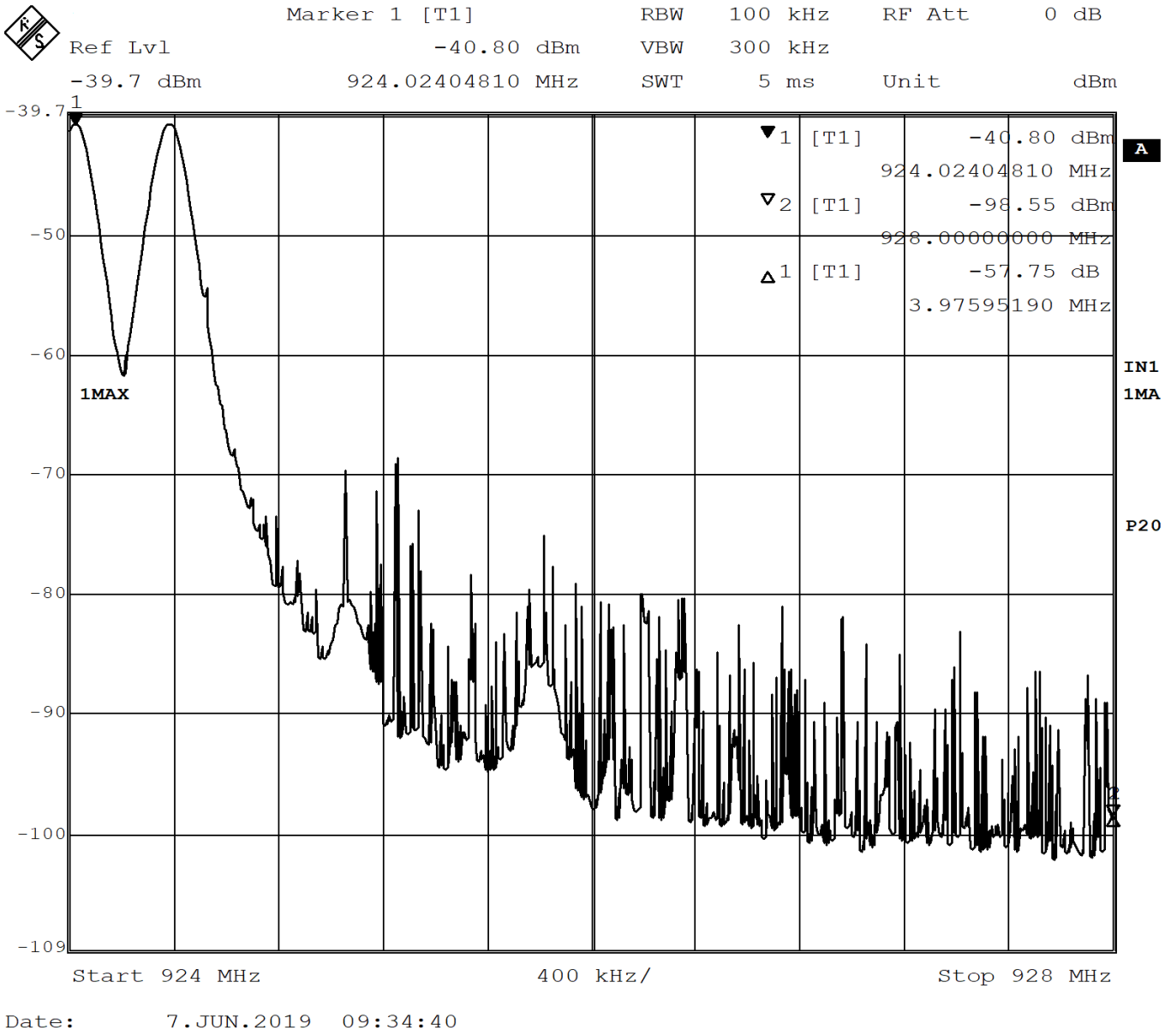

Figure 24 - Band-edge Measurement, High Channel, Fundamental, Hopping Transmit

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

Delta = 49.03 dB > 20 dB minimum

4.6 CARRIER FREQUENCY SEPERATION, NUMBER OF HOPPING CHANNELS, TIME OF OCCUPANCY

Test Method: ANSI C63.10, Section 7.8.2, 7.8.3, 7.8.4

Limits for Time of Occupancy

Average time of occupancy on any frequency should not to exceed 0.4 seconds within a 20 second period.

Test procedures:
The method from FCC DA 00-705

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

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 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:

See Figures 1 and 2 in Section 4.1 for time of occupancy. The EUT only transmits at most 1 packet per 50 s period and each packet is 10.42 ms. (20 sec / 50 sec) x 0.01042 = 0.004 sec

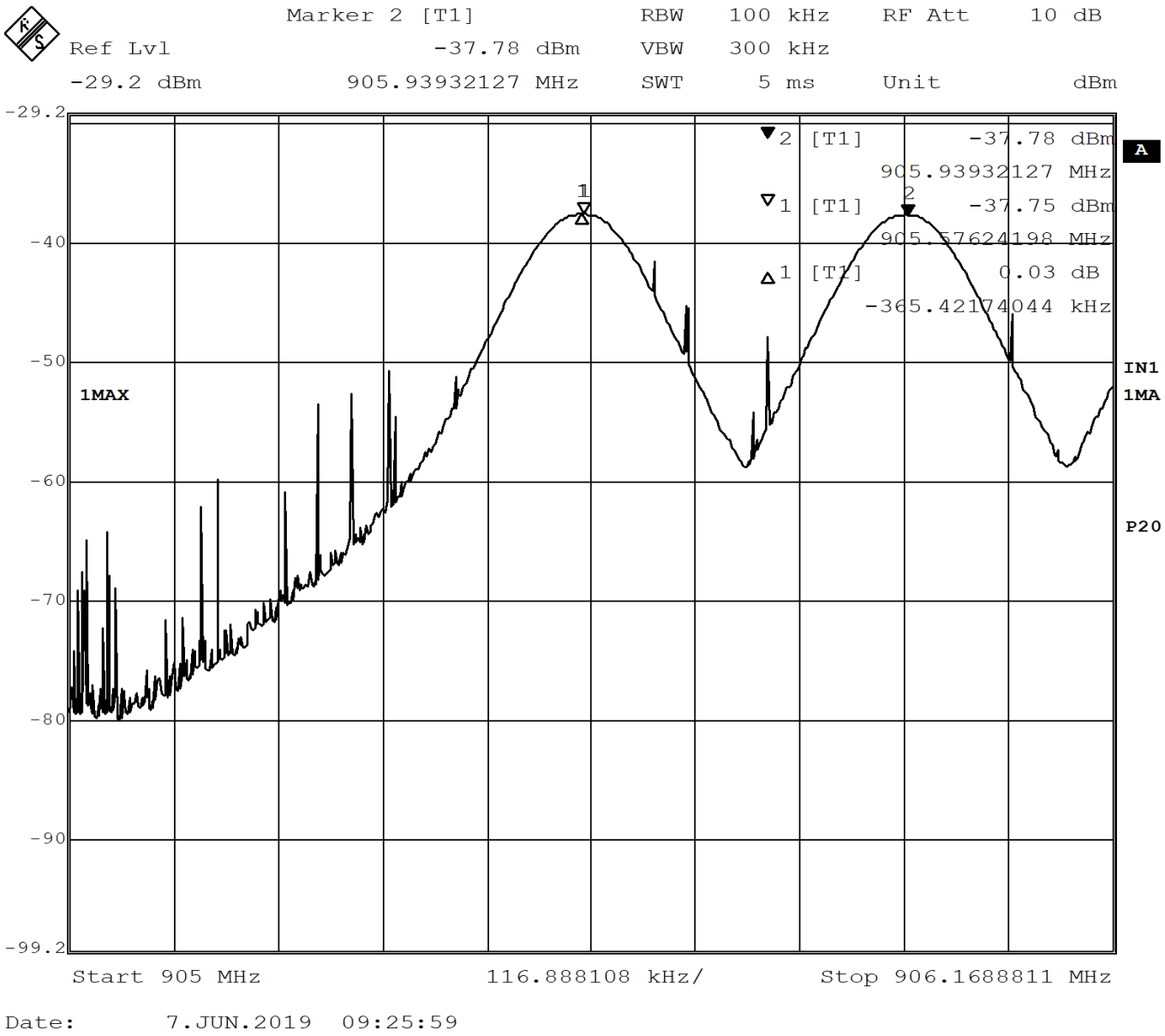

Figure 25 – Frequency Separation, 365.42 kHz

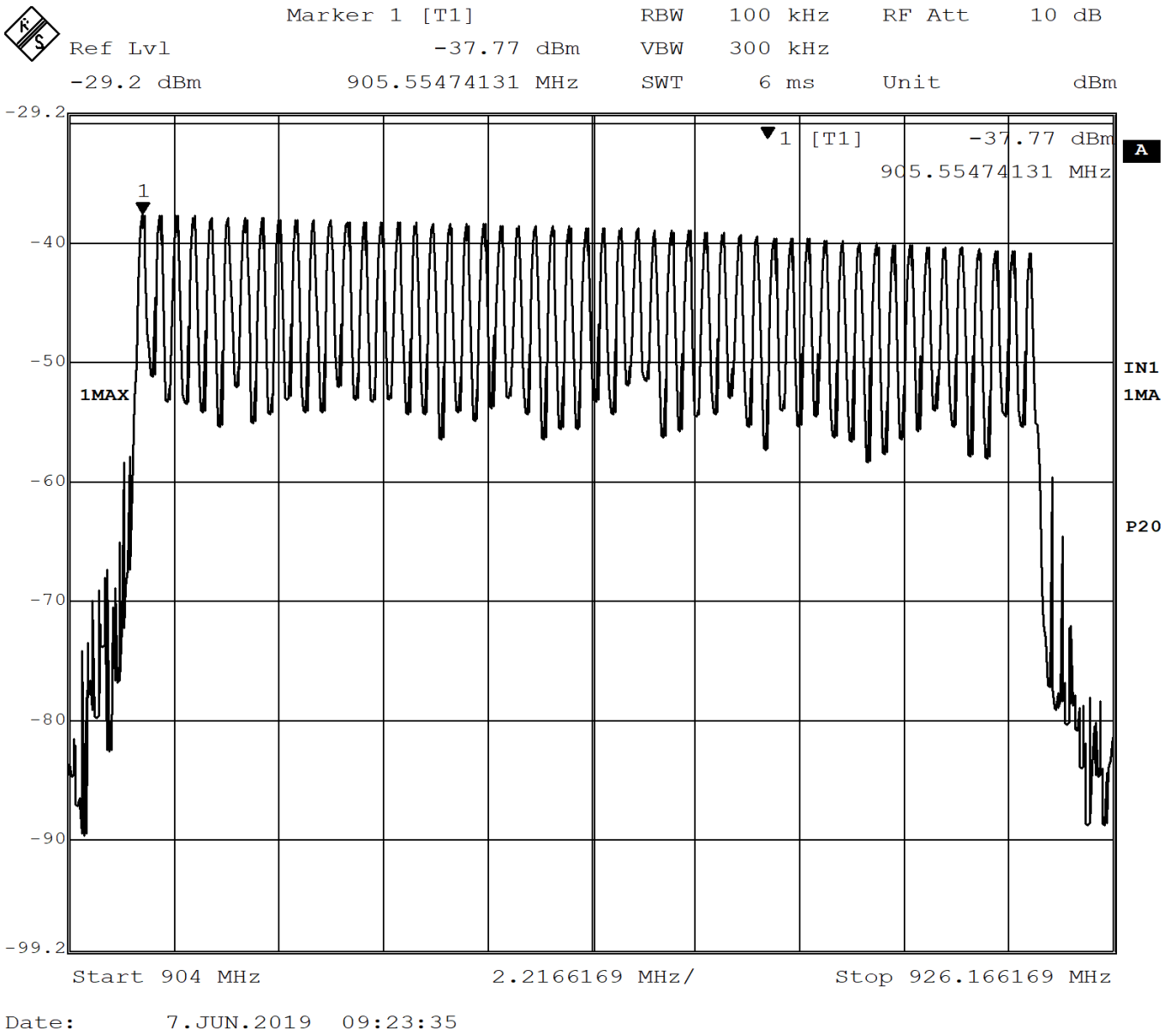

Figure 26 – Hop Count, 53 Hops

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 12 VDC unless specified and set to transmit continuously on the middle channel.

Test Results:

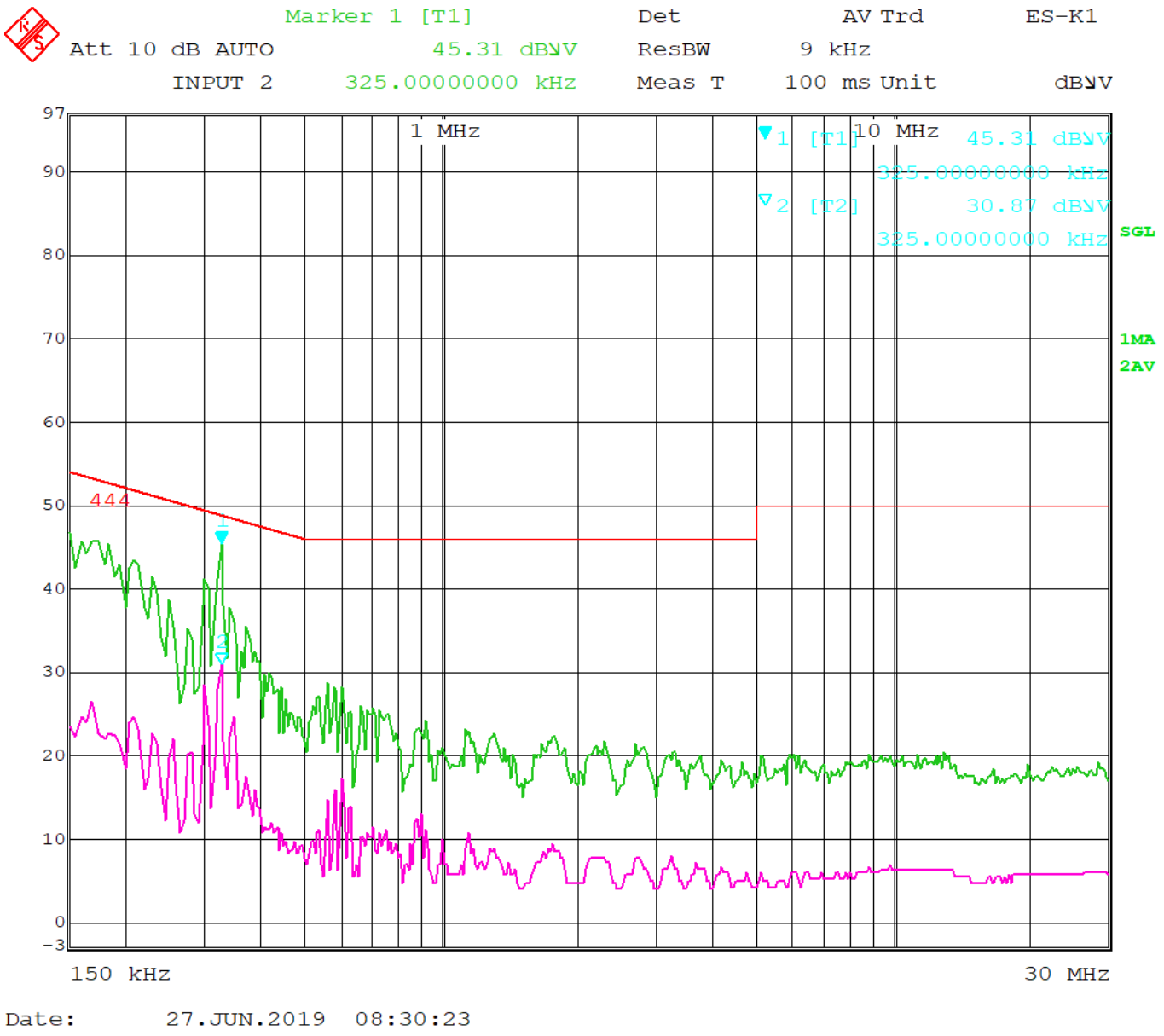

Figure 27 - Conducted Emissions, Line

Tabular data is shown on the screencap above. All Other Measurements were found to be at least 10 dB below the limits.

The average limit at 320 kHz is 49.7 dBuV/m. The margin is 18.83 dB

The peak limit at 320 kHz is 69.7 dBuV/m. The margin is 24.39 dB

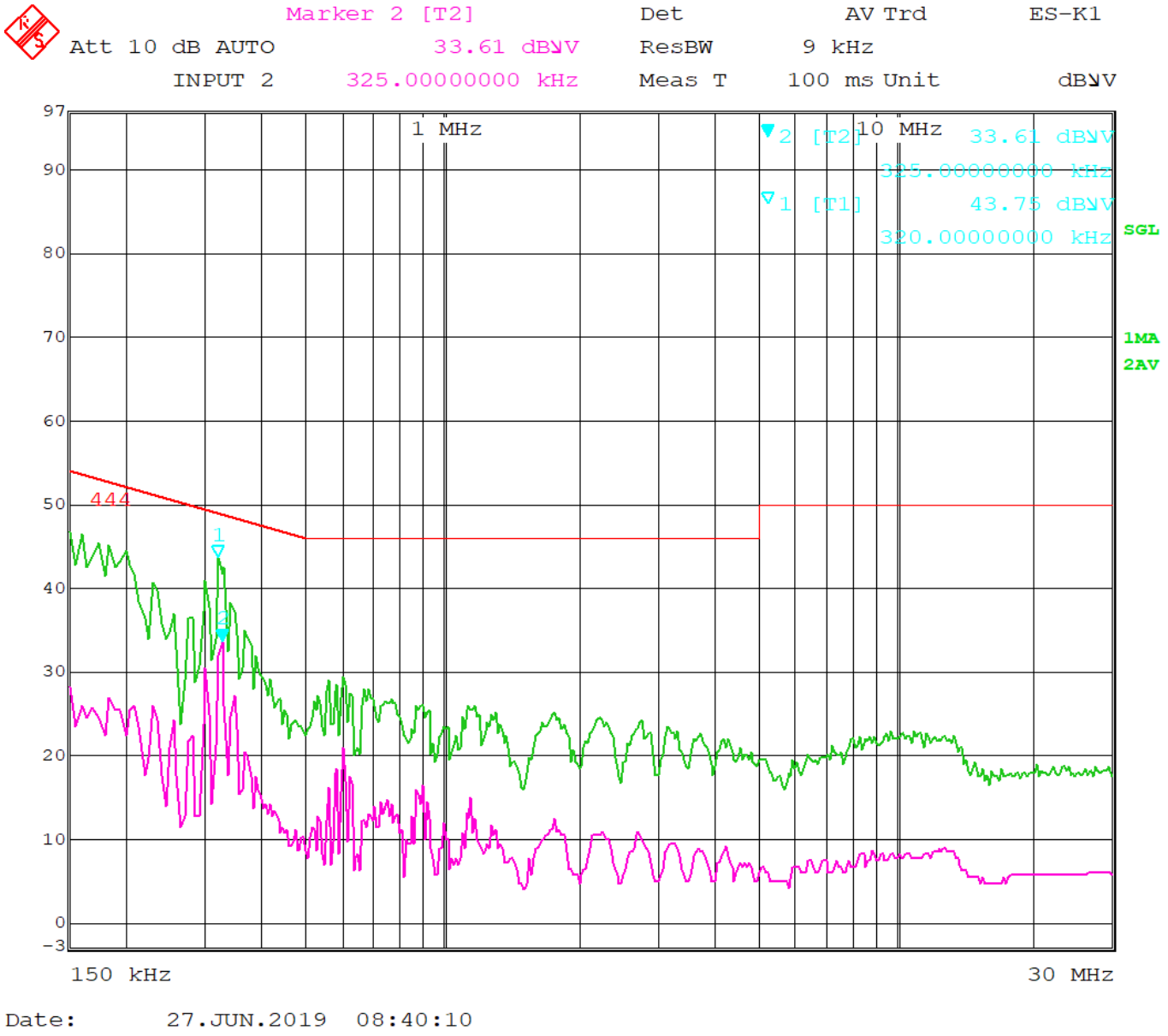

Figure 28 - Conducted Emissions, Neutral

Tabular data is shown on the screencap above. All Other Measurements were found to be at least 10 dB below the limits.

The average limit at 320 kHz is 49.7 dBuV/m. The margin is 16.09 dB

The peak limit at 320 kHz is 69.7 dBuV/m. The margin is 25.95 dB

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