

Amended
FCC/ISED Test Report

Prepared for: Digital Monitoring Products

Address: 2500 North Partnership Blvd.
Springfield, MO 6582

Product: 1134

Test Report No: R20190123-21A

Approved by:



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DATE: 26 February 2019

Total Pages: 53

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REVISION PAGE

Rev. No.	Date	Description
0	26 February 2019	Original – NJohnson Prepared by KVepuri/CFarrington
A	22 March 2019	Updated test mode frequencies. Added note about testing with cables and maximization to Section 4.1 Includes NCEE Labs report R20190123-21 and its amendment in full -NJohnson



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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

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	NA	Duty cycle was not applied
FCC 15.209 RSS-Gen, 7.1	Receiver Radiated Emissions	NA	The EUT has no receiver functionality
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	Pass	EUT runs on a replaceable battery



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2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary

The Equipment Under Test (EUT) was 1134 a Wireless transmitter manufactured by DMP wireless devices. It operates in the 900 to 928 MHz ISM band and has transmit and receive capabilities.

EUT	1134
EUT Received	2/15/2019
EUT Tested	2/15/2019 - 2/20/2019
Serial No.	NCEEETEST1 (Assigned; PC-0205-R0 - PCB no.)
Operating Band	900.0 – 928.0 MHz
Device Type	FHSS
Power Supply	12 VDC (representative power supply MG Electronics MN: MGT-12500-SPS)

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



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2.2 DESCRIPTION OF TEST MODES

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

Channel	Frequency
Low	905.6
Middle	914.7
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 $35 \pm 4\%$
 Temperature of $22 \pm 3^\circ$ 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	Caleb Farrington	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.



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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
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	25 Jul 2017	25 Jul 2018
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*
Rohde and Schwarz Software	ES-K1 v1.60	2575	NA	NA

*Internal Characterization

Notes:

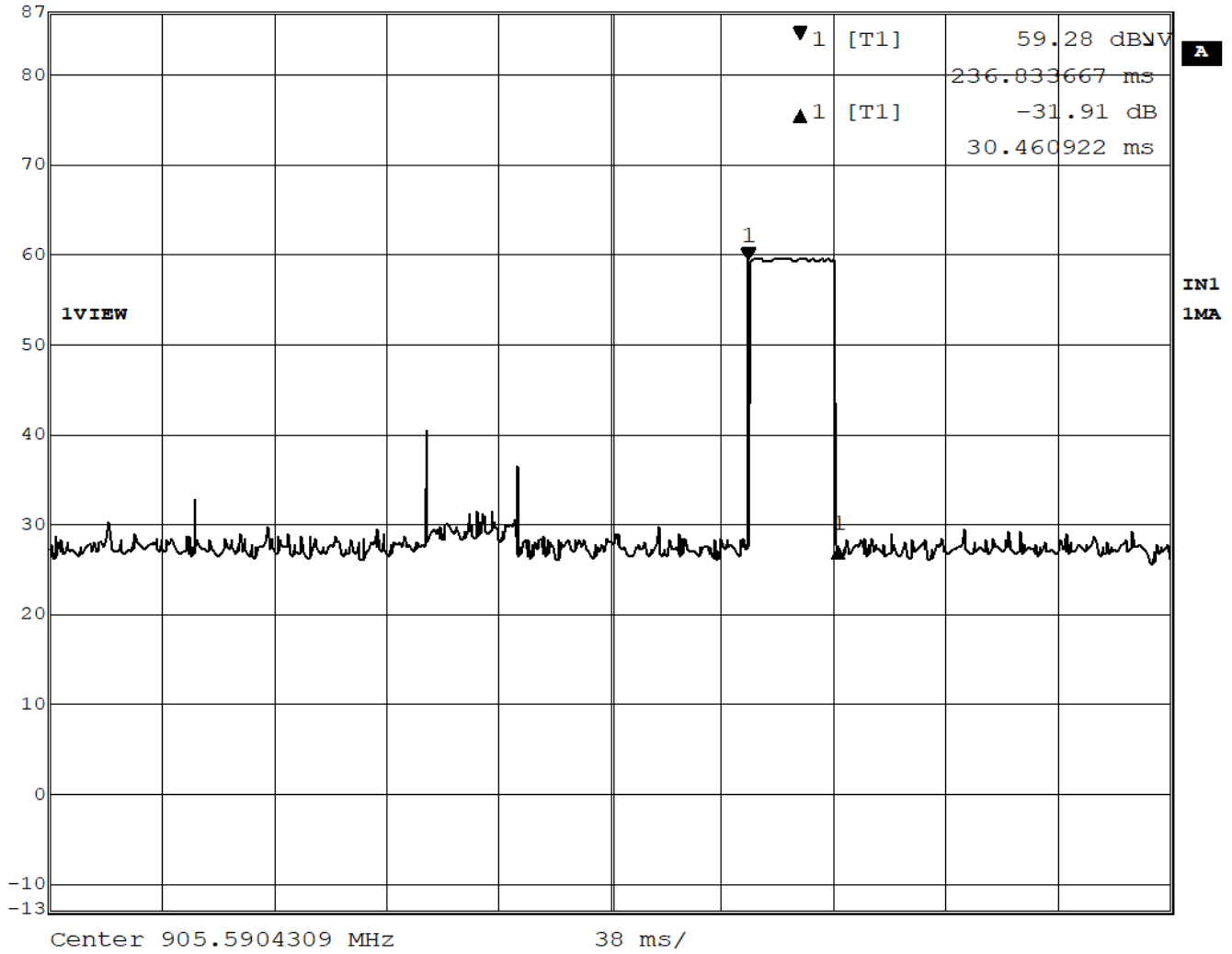
All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

4.0 DETAILED RESULTS

4.1 DUTY CYCLE



Delta 1 [T1]	RBW	100 kHz	RF Att	10 dB
Ref Lvl	-31.91 dB	VBW	300 kHz	
87 dBV	30.460922 ms	SWT	380 ms	Unit dBV

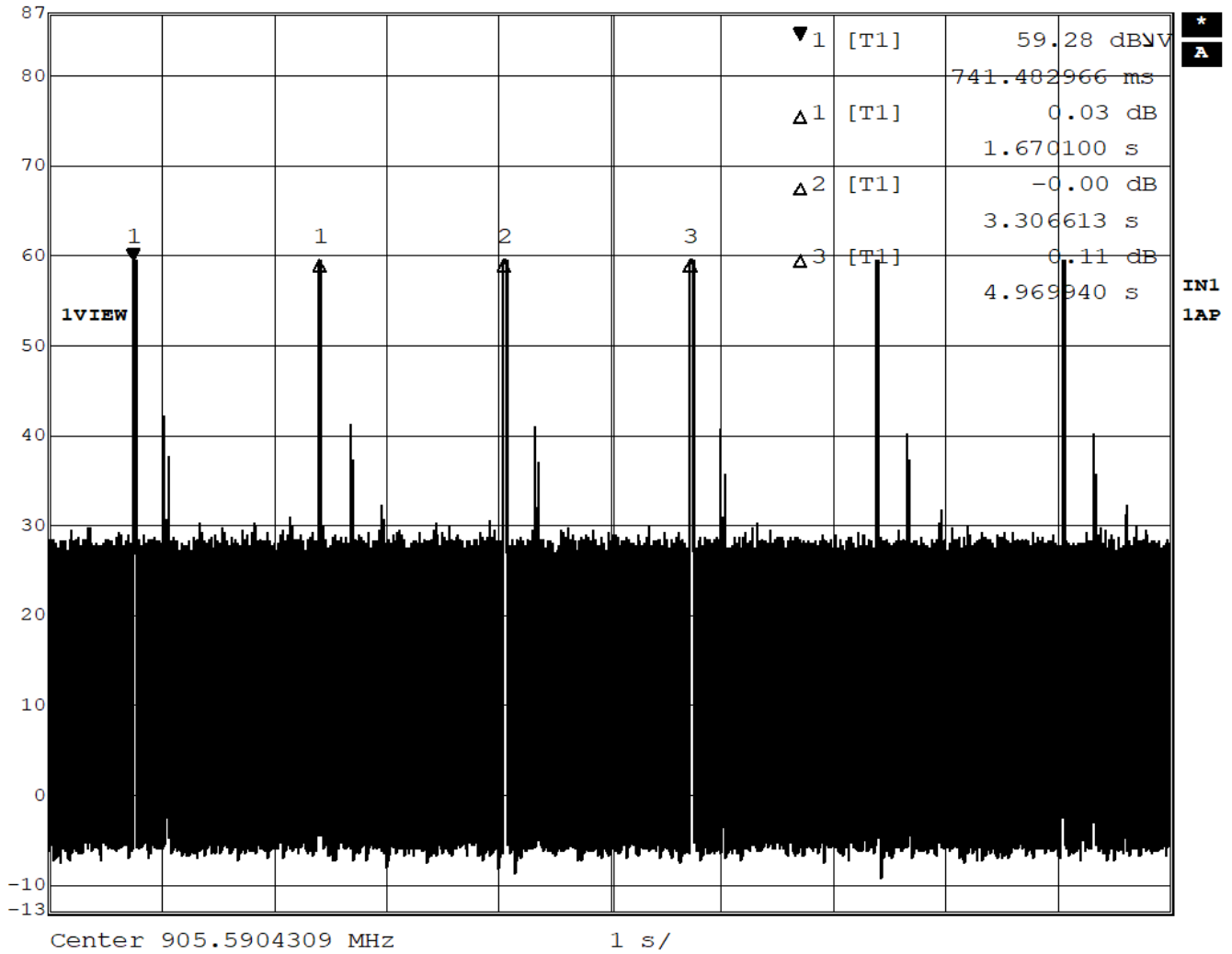


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Figure 1 – On Time



Marker 1 [T1] RBW 100 kHz RF Att 10 dB
 Ref Lvl 59.28 dBμV VBW 300 kHz
 87 dBμV 741.482966 ms SWT 10 s Unit dBμV



Date: 15.FEB.2019 07:29:59

Figure 2 –Period

Maximum On time in 100 ms window = 30.46 ms

Duty cycle correction factor = $20 \cdot \log((30.46)/100) = -10.33 \text{ dB}$

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 ($\mu\text{V/m}$)	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) = $20 * \log * \text{Emission level } (\mu\text{V/m})$.
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.



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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 EUT was tested with and without all possible IO cable orientations. In addition, the cables were maximized during the preview scan. The orientation with the worst-case emissions was used for final measurements.

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.

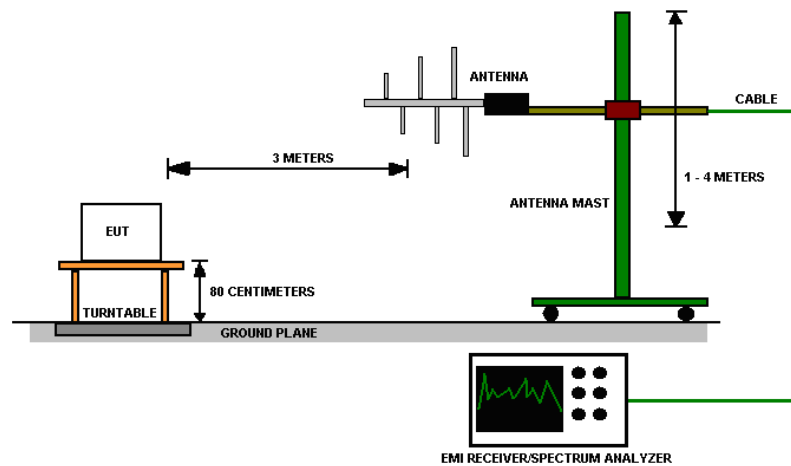
Test setup:


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.

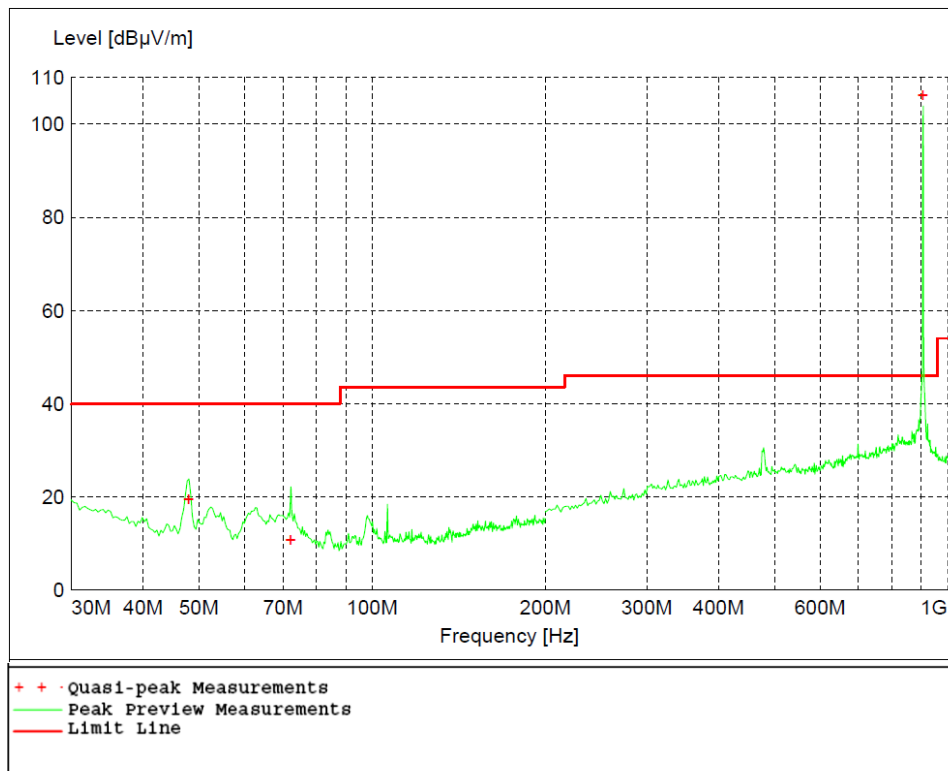
Test results:


Figure 4 - Radiated Emissions Plot, Low Channel

REMARKS:

1. Emission level (dBµV/m) = Raw Value (dBµV) + 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.



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

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
48.000000	19.51	40.00	20.50	261	0	VERT
72.180000	10.95	40.00	29.00	186	182	VERT
905.580000	106.22	NA	NA	115	274	HORI

Table 2 - Radiated Emissions Average Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
1811.200000	34.78	54.00	19.22	211	182	HORI
3622.400000	38.82	54.00	15.18	194	178	VERT
5433.600000	47.97	54.00	6.03	339	125	HORI
6339.000000	40.57	54.00	13.43	173	175	VERT
7244.600000	44.08	54.00	9.92	234	165	HORI
9055.600000	43.36	54.00	10.64	247	219	VERT

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.
 Average Level = Peak Level – 10.33(Duty Cycle Correction Factor)

Table 3 - Radiated Emissions Peak Measurements, Low Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dB μ V/m	dB μ V/m	dB	cm.	deg.	
1811.200000	45.11	74.00	28.89	211	182	HORI
3622.400000	49.15	74.00	24.85	194	178	VERT
5433.600000	58.30	74.00	15.70	339	125	HORI
6339.000000	50.90	74.00	23.10	173	175	VERT
7244.600000	54.41	74.00	19.59	234	165	HORI
9055.600000	53.69	74.00	20.31	247	219	VERT

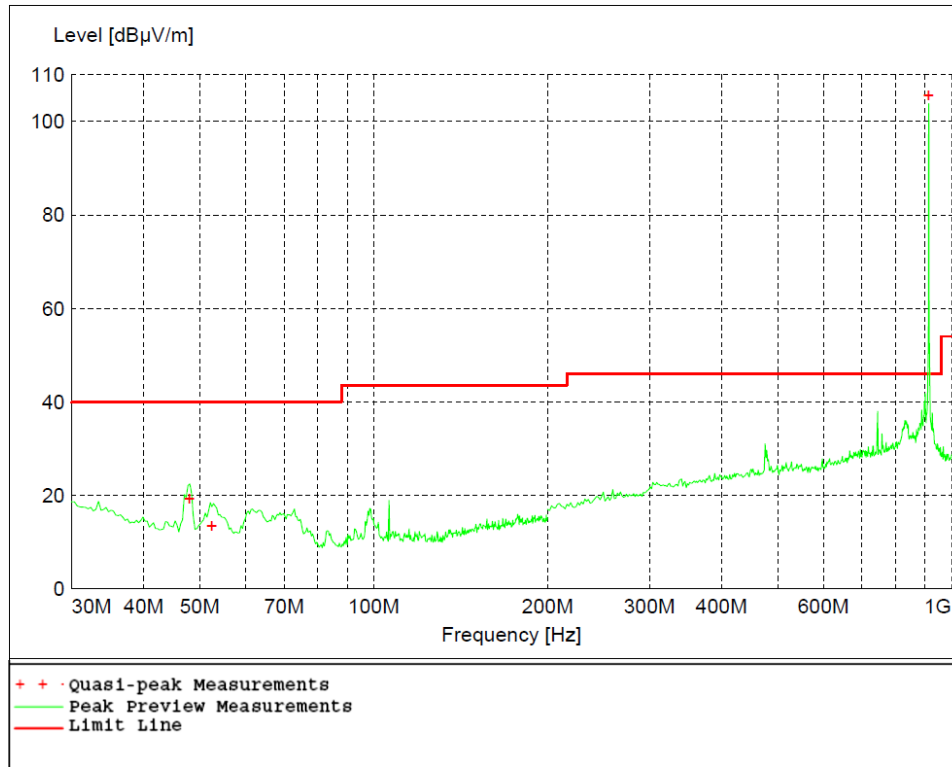


Figure 5 - Radiated Emissions Plot, Mid Channel

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.

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

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
48.000000	19.39	40.00	20.60	261	98	VERT
52.500000	13.53	40.00	26.50	100	250	VERT
912.70000	105.57	NA	NA	115	80	HORI

Table 5 - Radiated Emissions Average Measurements, Mid Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1818.400000	34.87	54.00	19.13	182	173	HORI
3636.800000	39.29	54.00	14.71	194	198	VERT
5455.400000	47.12	54.00	6.88	153	0	HORI
6364.600000	40.1	54.00	13.90	217	192	VERT
7273.400000	43.45	54.00	10.55	227	150	HORI

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the table above.
Average Level = Peak Level – 10.33(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.	
1818.400000	45.20	74.00	28.80	182	173	HORI
3636.800000	49.62	74.00	24.38	194	198	VERT
5455.400000	57.45	74.00	16.55	153	0	HORI
6364.600000	50.43	74.00	23.57	217	192	VERT
7273.400000	53.78	74.00	20.22	227	150	HORI

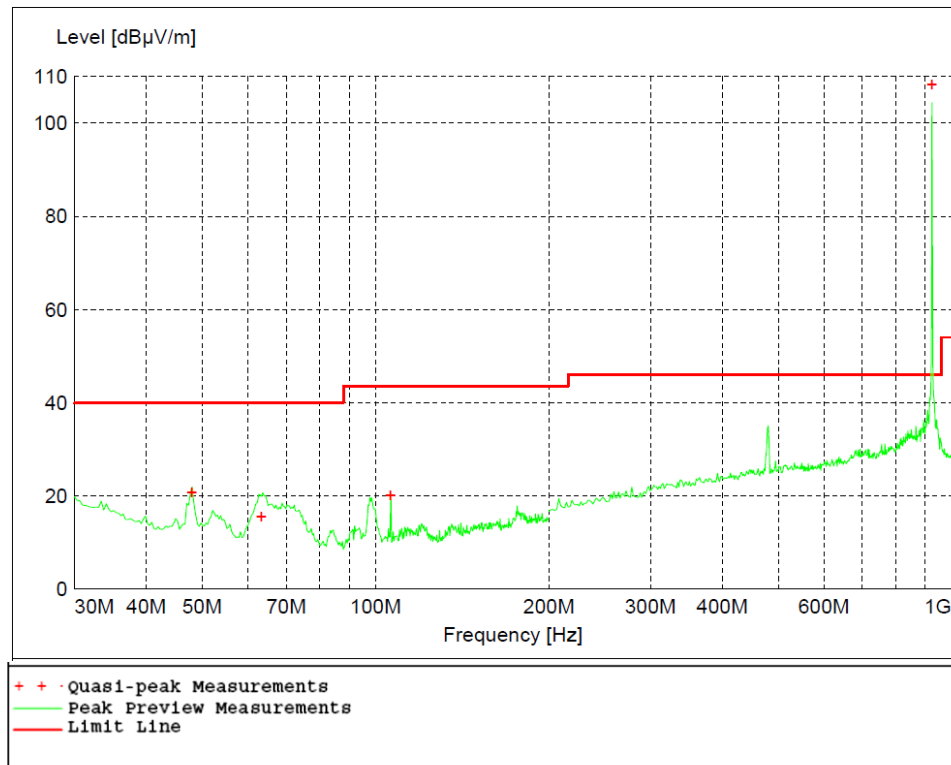


Figure 6 - Radiated Emissions Plot, High Channel

REMARKS:

1. Emission level (dBµV/m) = Raw Value (dBµV) + 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.

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

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
48.000000	20.84	40.00	19.20	274	360	VERT
63.360000	15.60	40.00	24.40	136	113	VERT
106.260000	20.29	43.50	23.20	206	144	HORI
924.420000	108.31	NA	NA	109	219	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.	
1825.600000	34.96	54.00	19.04	244	187	HORI
3651.200000	38.51	54.00	15.49	214	182	VERT
5477.000000	46.98	54.00	7.02	206	217	HORI
6389.600000	40.16	54.00	13.84	190	188	VERT
7302.400000	43.76	54.00	10.24	200	145	HORI
9128.000000	42.83	54.00	11.17	260	214	VERT

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

Average Level = Peak Level – 10.33(Duty Cycle Correction Factor)

*Unrestricted band, the level need to be 20 dB below the fundamental; Pass.

Table 9 - Radiated Emissions Peak Measurements, High Channel

Frequency	Level	Limit	Margin	Height	Angle	Pol
MHz	dBµV/m	dBµV/m	dB	cm.	deg.	
1825.600000	45.29	74.00	28.71	244	187	HORI
3651.200000	48.84	74.00	25.16	214	182	VERT
5477.000000	57.31	74.00	16.69	206	217	HORI
6389.600000	50.49	74.00	23.51	190	188	VERT
7302.400000	54.09	74.00	19.91	200	145	HORI
9128.000000	53.16	74.00	20.84	260	214	VERT

Note: receive mode was also examined. All emissions were at least 10 dB below the limit.

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

Measurement device used was power meter

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.

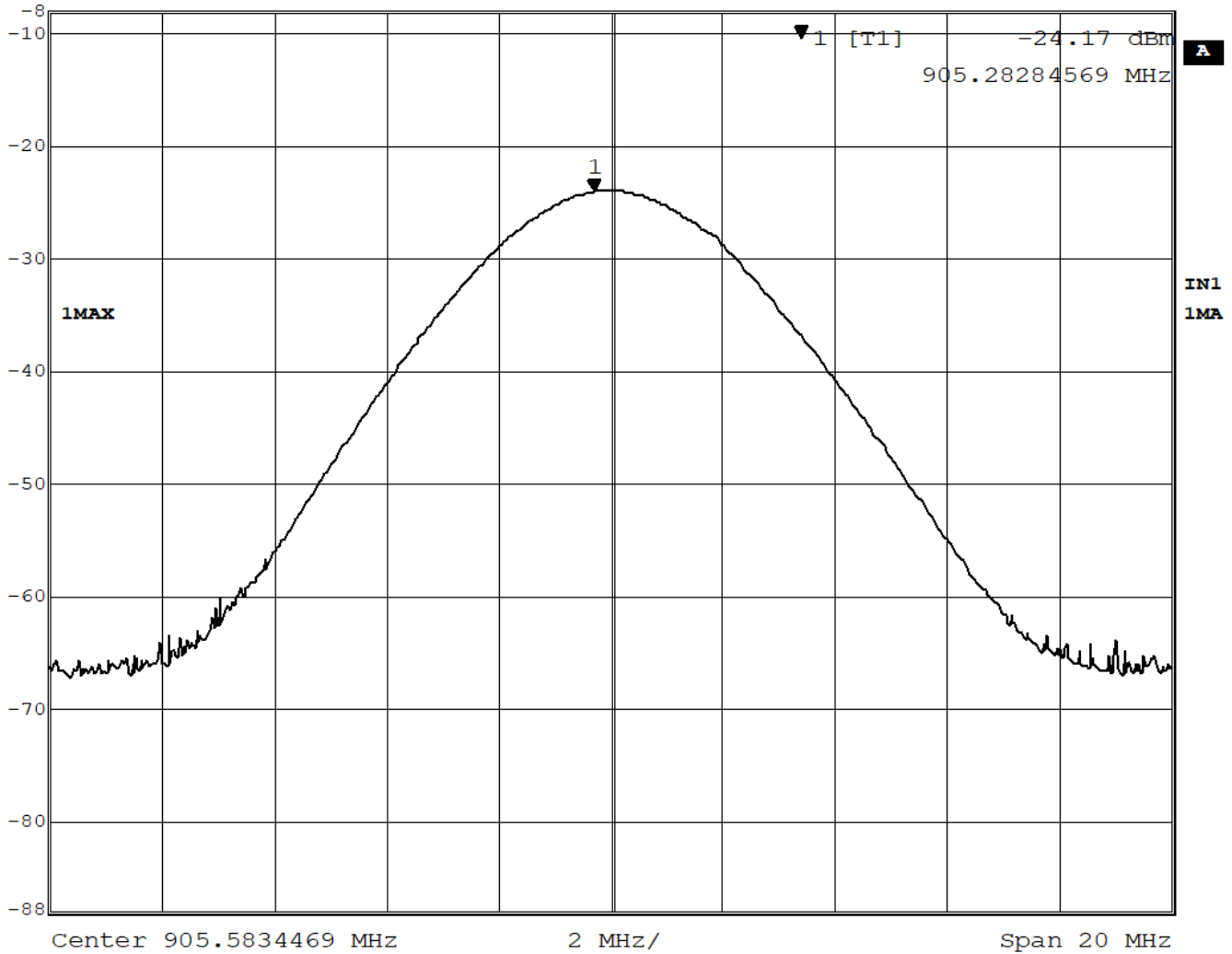
Test results:

Peak Output Power

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK OUTPUT POWER (dBm)	Method	RESULT
Low	905.6	16.00	EIRP	PASS
Middle	914.7	15.90	EIRP	PASS
High	924.4	15.81	EIRP	PASS



Marker 1 [T1]	RBW	3 MHz	RF Att	10 dB
Ref Lvl	-24.17 dBm	VBW	10 MHz	
-8 dBm	905.28284569 MHz	SWT	5 ms	Unit dBm



Date: 19.FEB.2019 12:10:17

Figure 7 – Output Power, Low Channel.

Maximum power = $-24.17 \text{ dBm} + 107 + \text{CL} + \text{AF} - 95.23 = 16.00 \text{ dBm}^*$

CL = cable loss = 4.80 dB

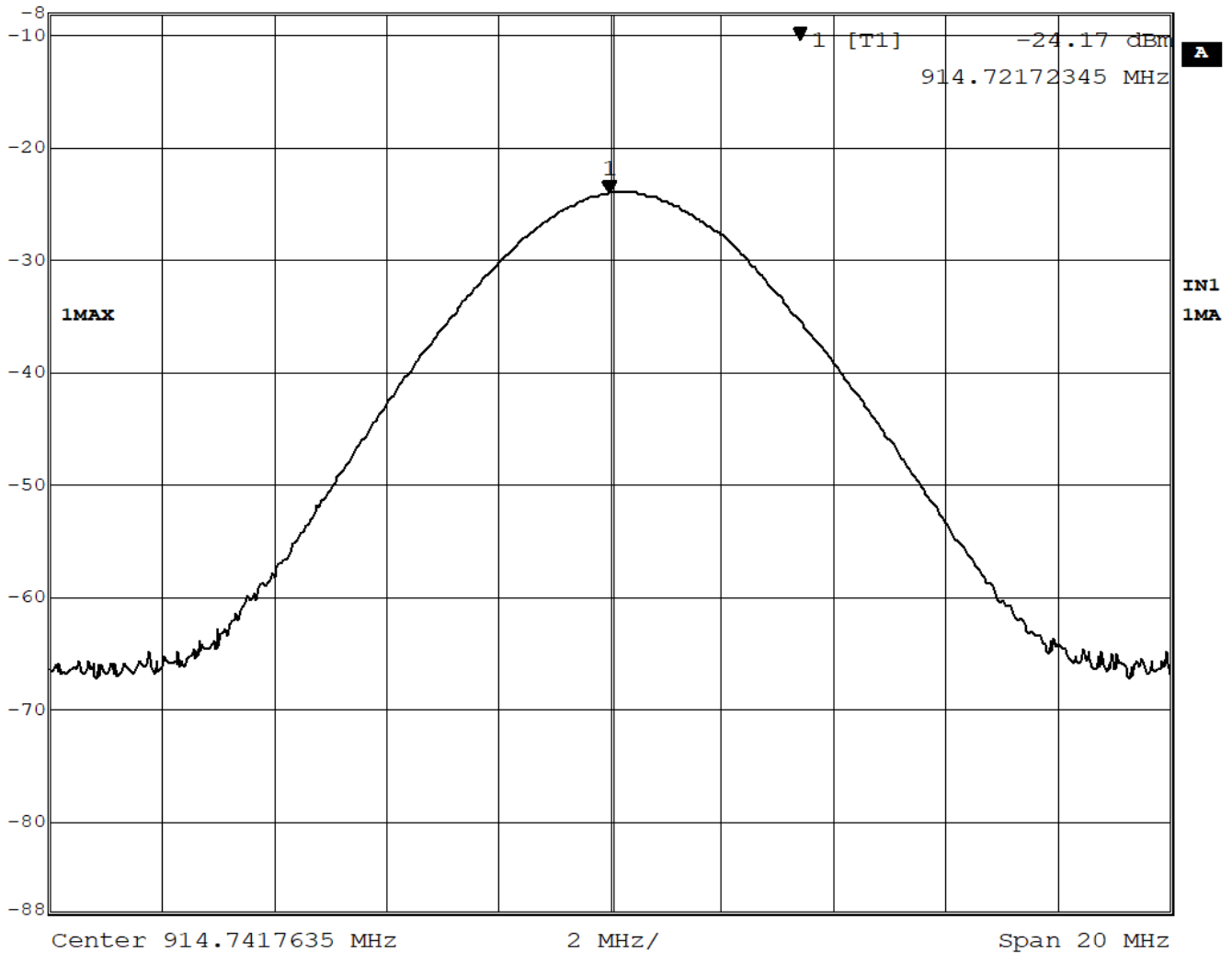
AF = antenna factor = 23.60 dB

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



Marker 1 [T1] RBW 3 MHz RF Att 10 dB
 Ref Lvl -24.17 dBm VBW 10 MHz
 -8 dBm 914.72172345 MHz SWT 5 ms Unit dBm



Date: 19.FEB.2019 12:13:47

Figure 8 – Output Power, Mid Channel

Maximum power = $-24.17 \text{ dBm} + 107 + \text{CL} + \text{AF} - 95.23 = 15.90 \text{ dBm}^*$

CL = cable loss = 4.80 dB

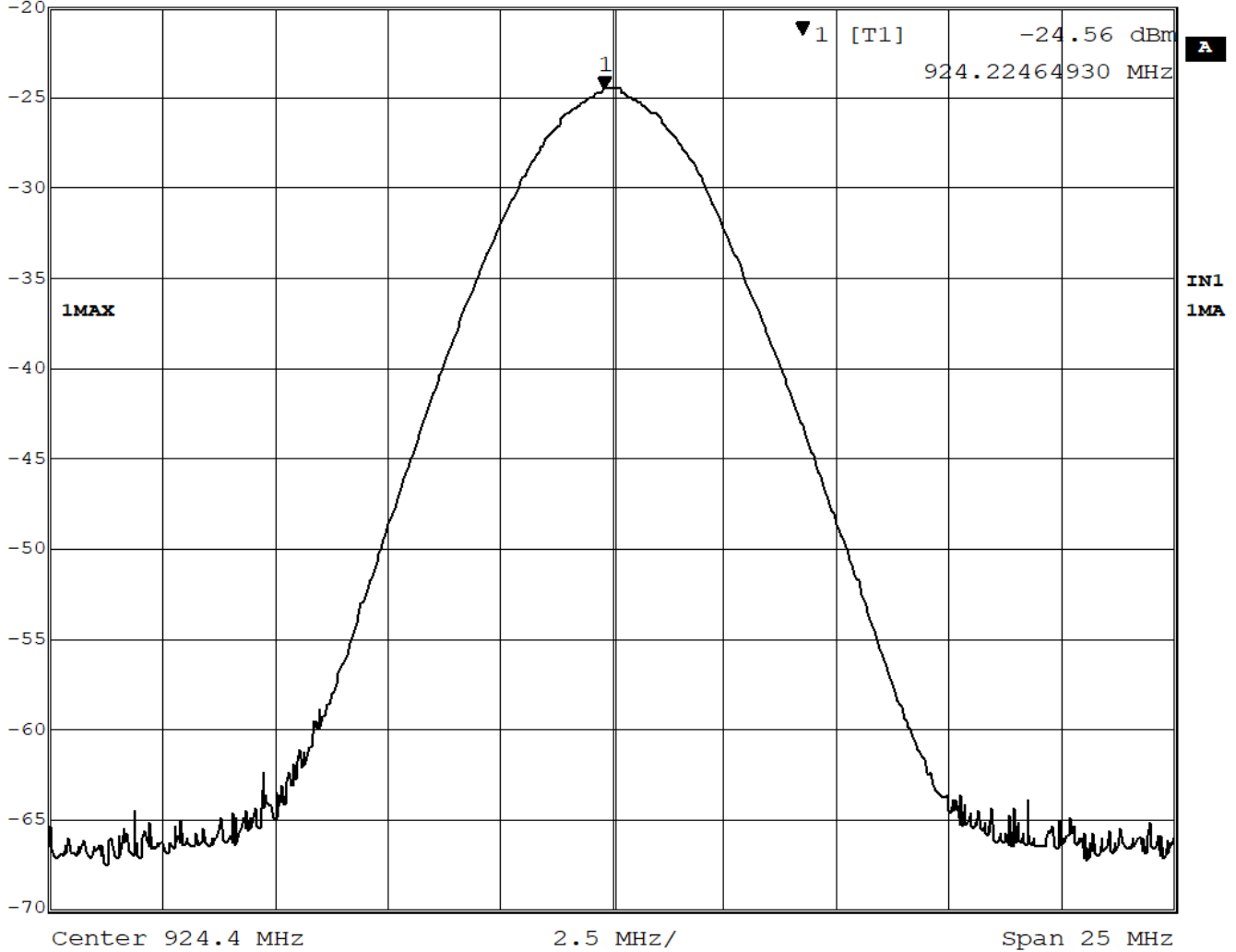
AF = antenna factor = 23.50 dB

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.



Marker 1 [T1]	RBW	3 MHz	RF Att	10 dB
Ref Lvl	-24.56 dBm	VBW	10 MHz	
-20 dBm	924.22464930 MHz	SWT	5 ms	Unit dBm



Date: 19.FEB.2019 10:31:12

Figure 9 – Output Power, High Channel

Maximum power = $-24.56 \text{ dBm} + 107 + \text{CL} + \text{AF} - 95.23 = 15.81 \text{ dBm}^*$

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.



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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.

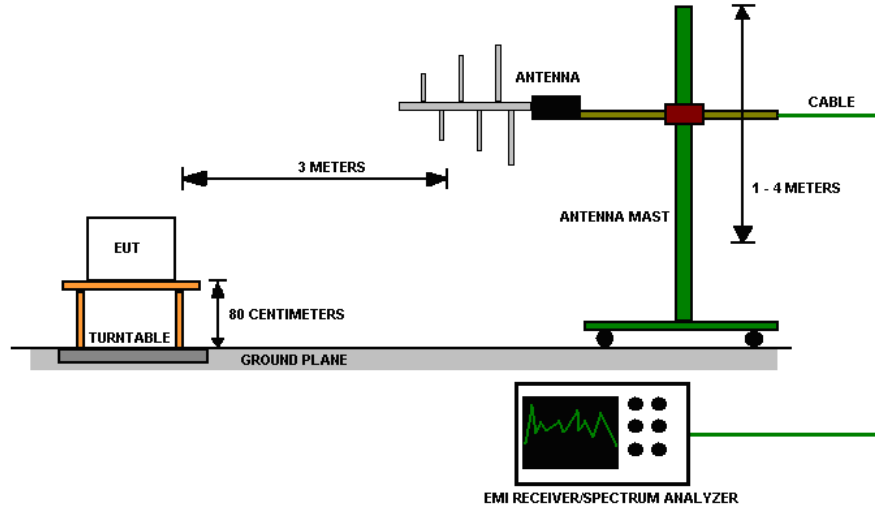
The 99% occupied bandwidth was measured using the test receiver's occupied bandwidth function.

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:

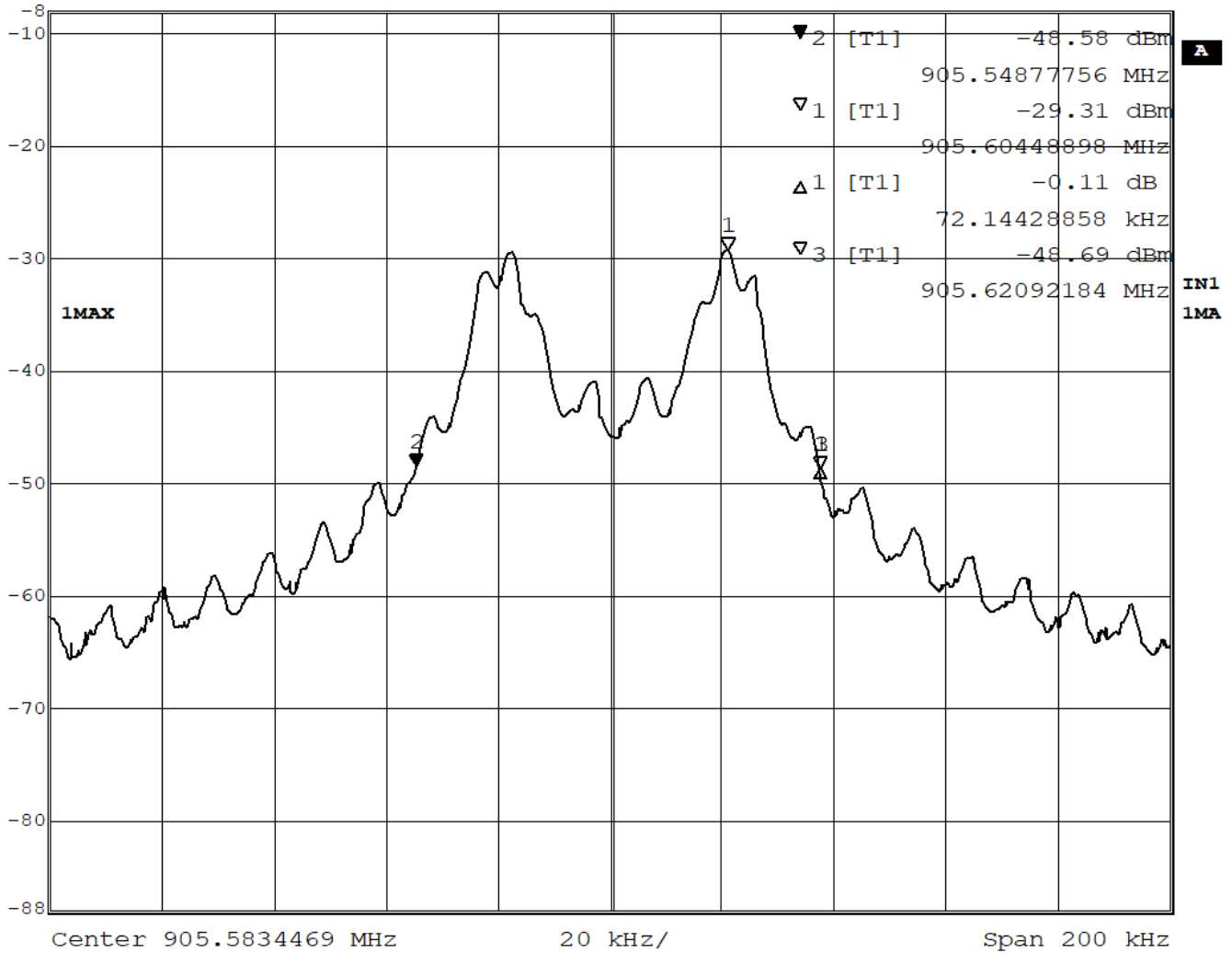
The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

Test results:

CHANNEL	CHANNEL FREQUENCY (MHz)	Bandwidth		RESULT
		20dB BW (kHz)	99% Occupied Bandwidth (kHz)	
Low	905.6	72.14	84.97	PASS
Mid	914.7	72.14	82.16	PASS
High	924.4	72.14	93.18	PASS



Marker 2 [T1] RBW 3 kHz RF Att 10 dB
 Ref Lvl -48.58 dBm VBW 10 kHz
 -8 dBm 905.54877756 MHz SWT 56 ms Unit dBm

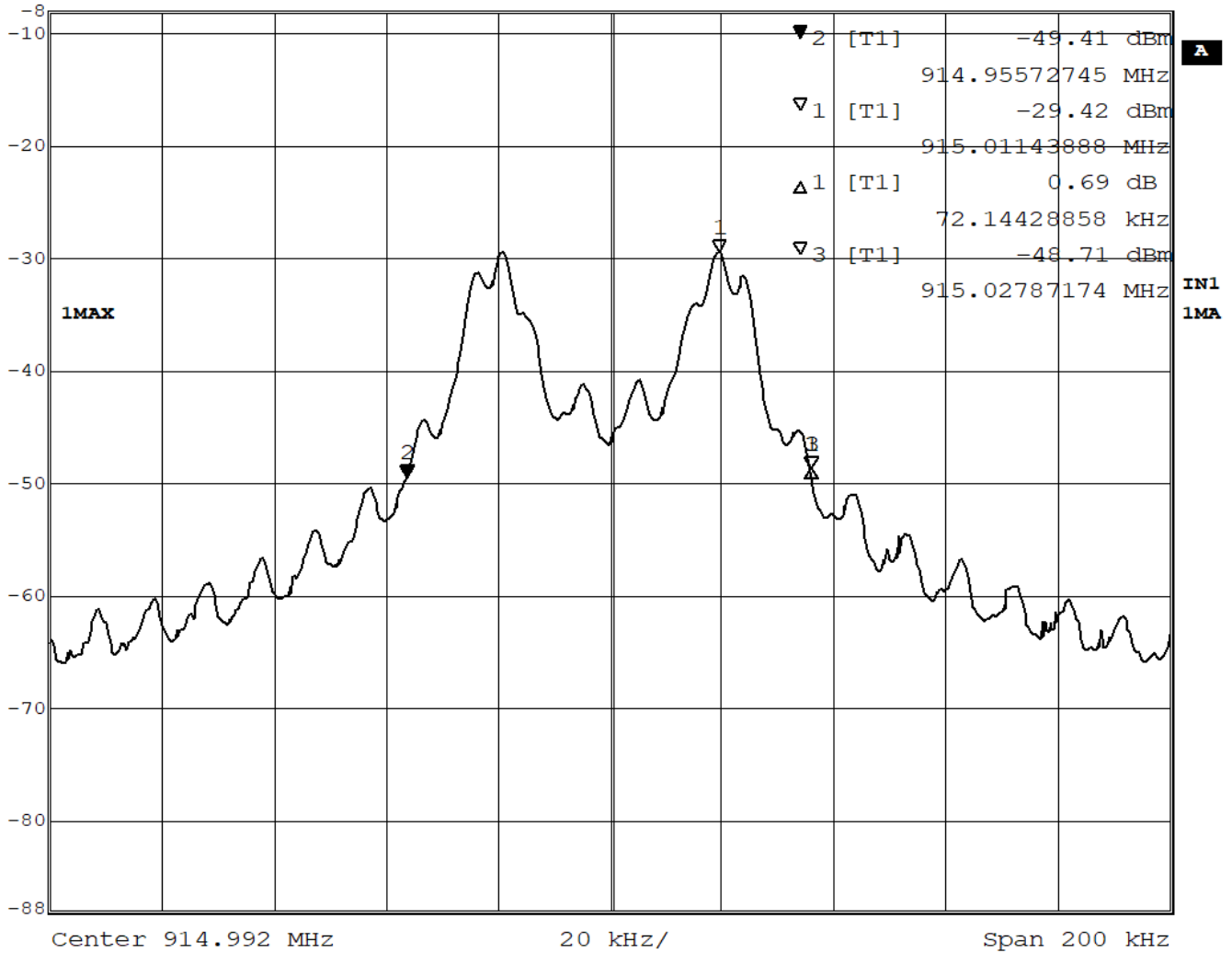


Date: 19.FEB.2019 12:08:23

Figure 11 – 20 dB Bandwidth, Low Channel



Marker 2 [T1] RBW 3 kHz RF Att 10 dB
 Ref Lvl -49.41 dBm VBW 10 kHz
 -8 dBm 914.95572745 MHz SWT 56 ms Unit dBm

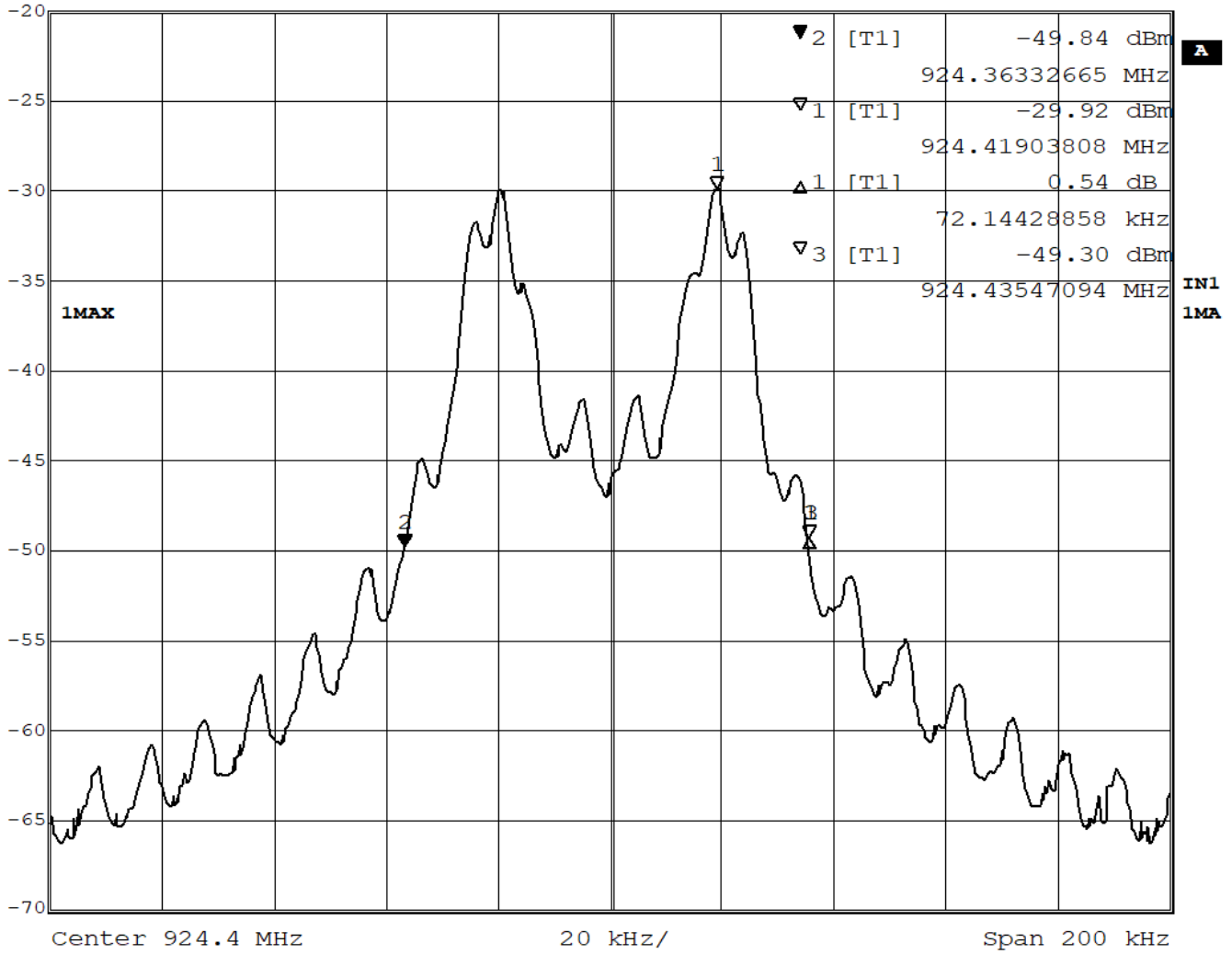


Date: 19.FEB.2019 12:16:35

Figure 12 - 20 dB Bandwidth, Mid Channel



Marker 2 [T1] RBW 3 kHz RF Att 10 dB
 Ref Lvl -49.84 dBm VBW 10 kHz
 -20 dBm 924.36332665 MHz SWT 56 ms Unit dBm

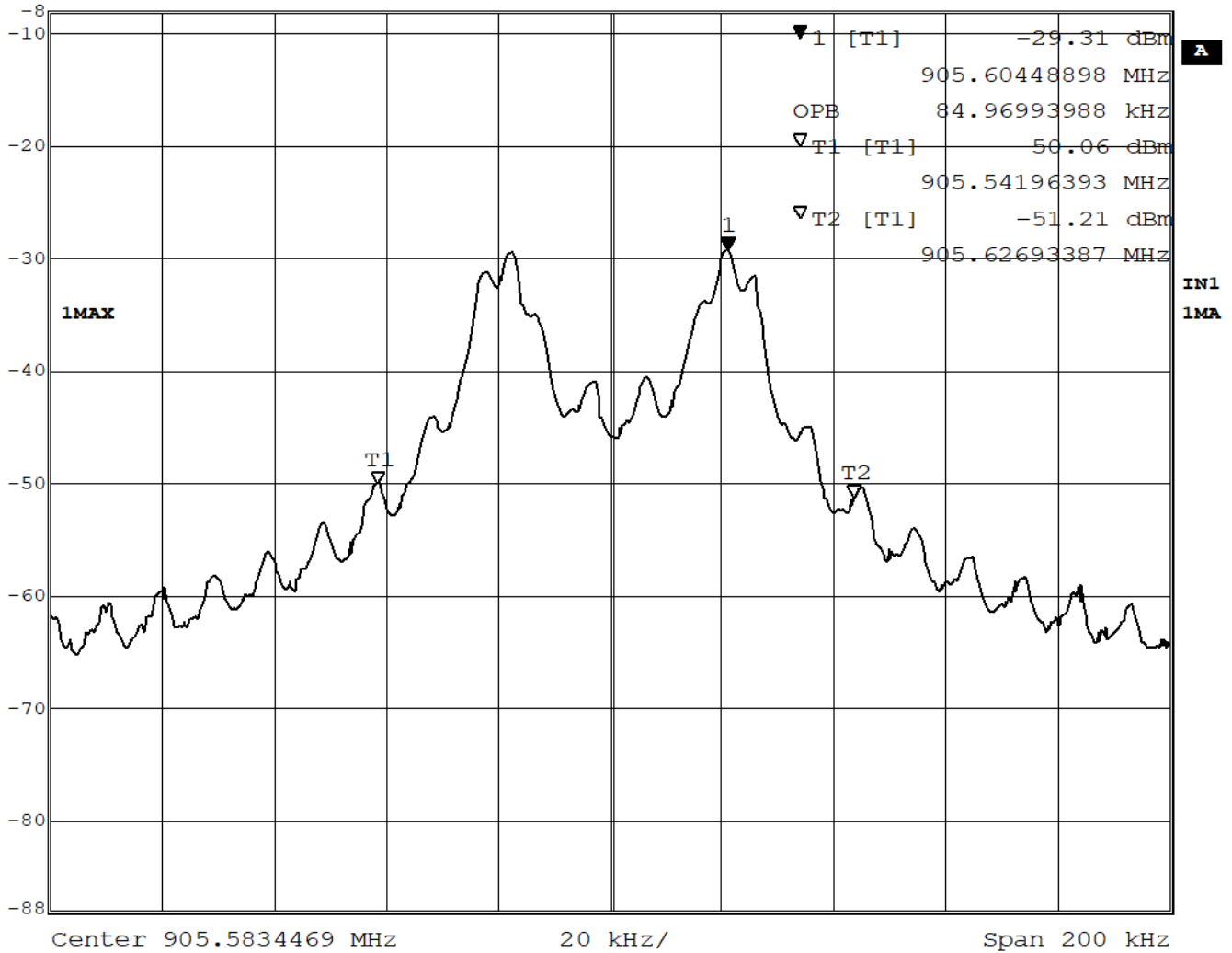


Date: 19.FEB.2019 10:26:08

Figure 13 - 20 dB Bandwidth, High Channel



Marker 1 [T1] RBW 3 kHz RF Att 10 dB
 Ref Lvl -29.31 dBm VBW 10 kHz
 -8 dBm 905.60448898 MHz SWT 56 ms Unit dBm

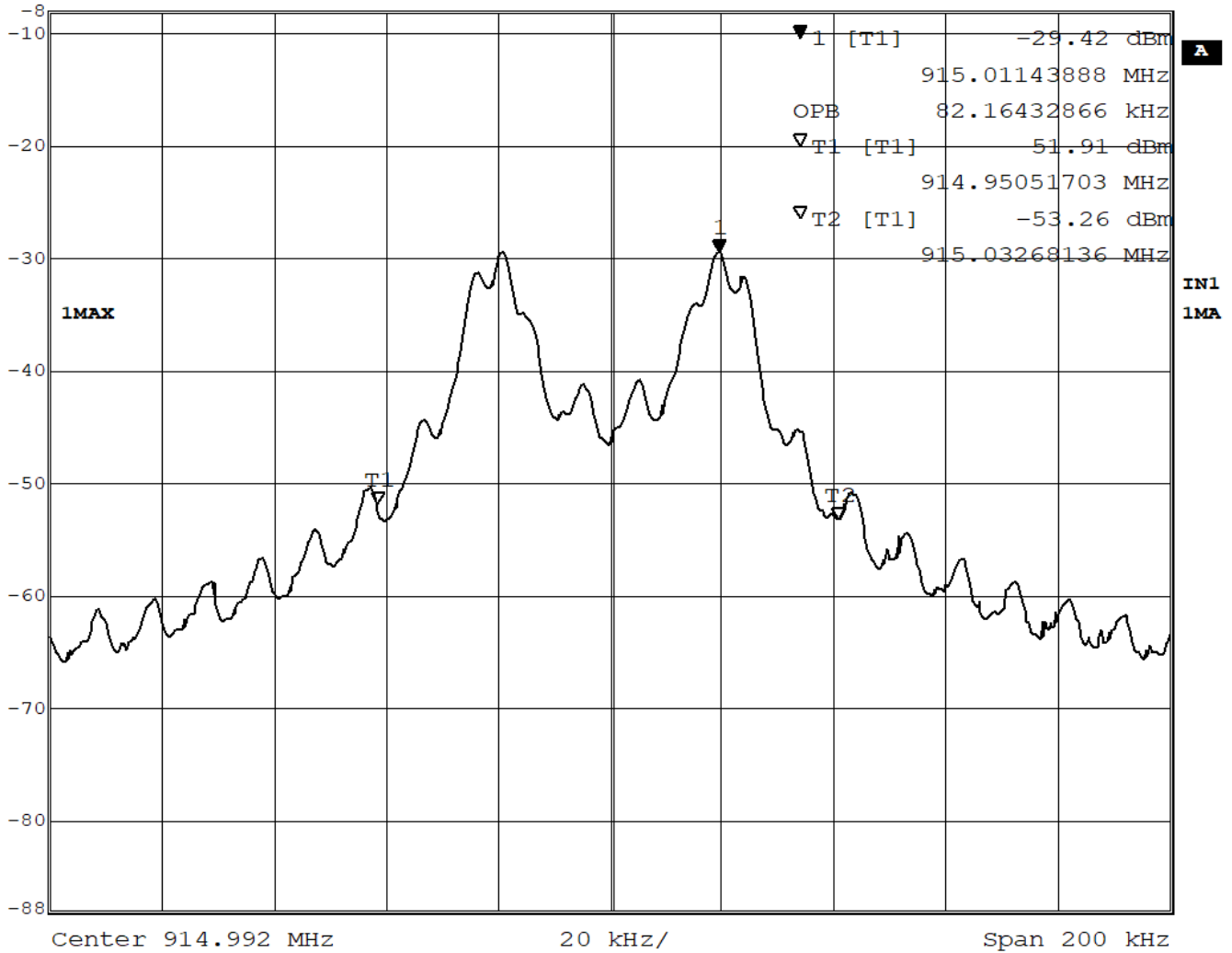


Date: 19.FEB.2019 12:09:11

Figure 14 - 99% Occupied Bandwidth, Low Channel



Marker 1 [T1] RBW 3 kHz RF Att 10 dB
 Ref Lvl -29.42 dBm VBW 10 kHz
 -8 dBm 915.01143888 MHz SWT 56 ms Unit dBm

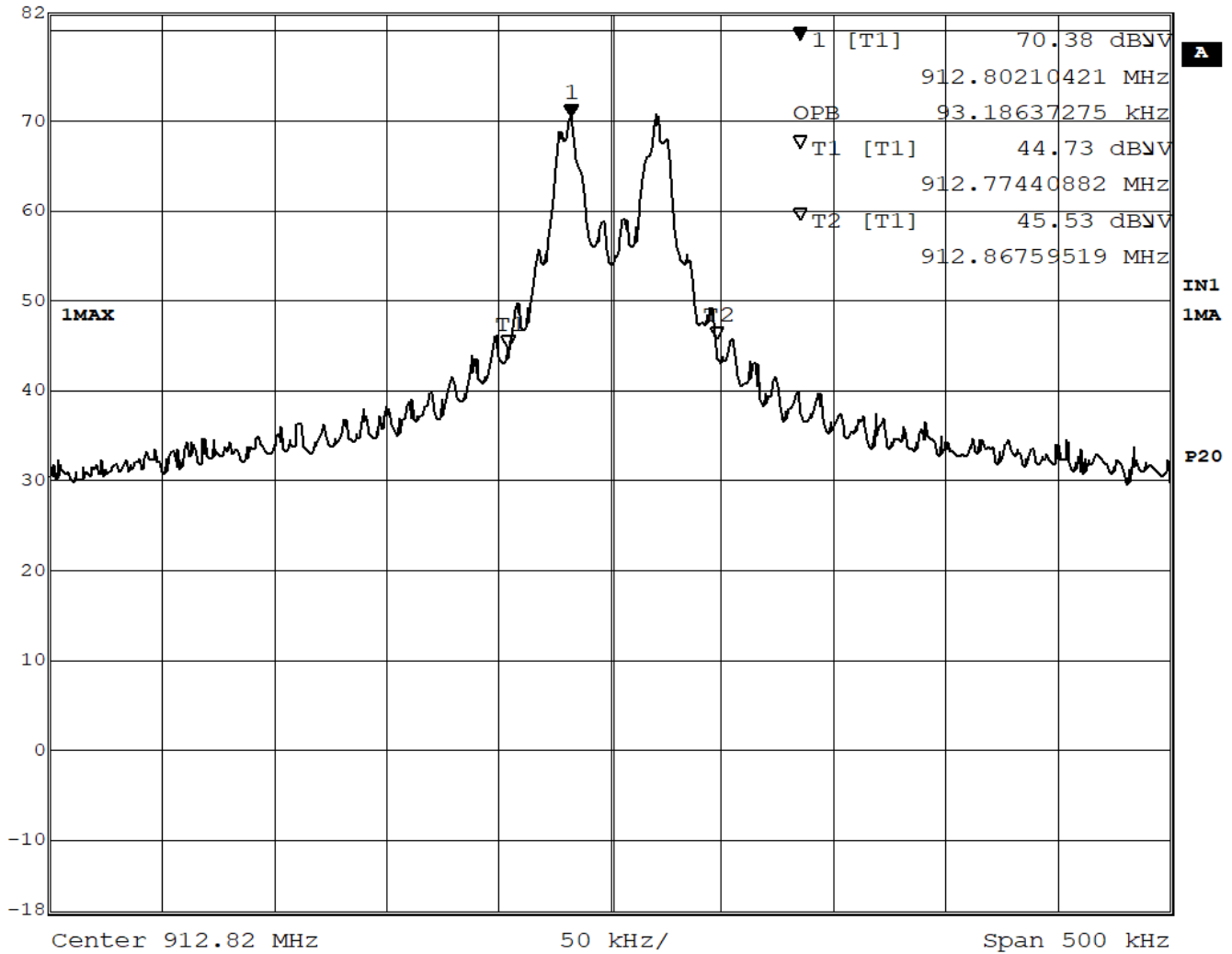


Date: 19.FEB.2019 12:17:44

Figure 15 - 99% Occupied Bandwidth, Middle Channel



Marker 1 [T1]	RBW	3 kHz	RF Att	10 dB
Ref Lvl	70.38 dBV	VBW	10 kHz	
82 dBV	912.80210421 MHz	SWT	140 ms	Unit dBV



Date: 15.FEB.2019 15:09:00

Figure 16 - 99% Occupied Bandwidth, High Channel



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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.



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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	-103.86	-24.26	79.60	69.14	PASS
High, Continuous Restricted	960	-102.93	-24.62	78.31	68.45	PASS
Low Hopping Restricted	614	-103.20	-28.28	74.92	69.14	PASS
High, Hopping Restricted	960	-103.19	-30.17	73.02	68.45	PASS
Low, Continuous Unrestricted	902	-77.66	-24.26	53.40	20.00	PASS
Low, Hopping Unrestricted	902	-79.04	-28.28	50.76	20.00	PASS
High, Continuous Unrestricted	928	-77.15	-24.62	52.53	20.00	PASS
High, Hopping Unrestricted	928	-80.03	-30.17	49.86	20.00	PASS

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

From Section 4.2

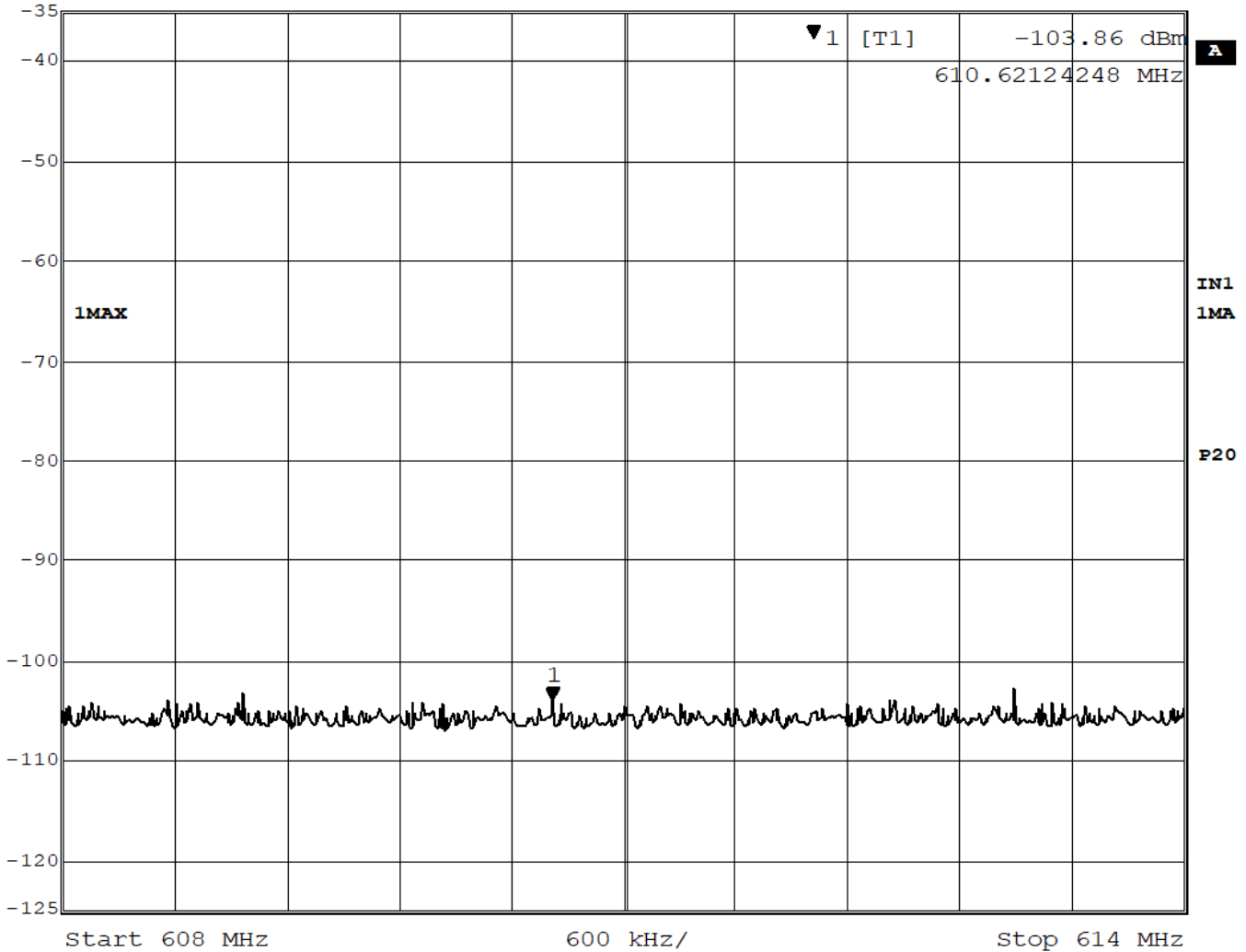
Fundamental average field strength at 905.6 MHz for low channel = 115.14 dBμV/m
Fundamental average field strength at 924.4 MHz for high channel = 114.45 dBμV/m

Low channel minimum delta = 115.14 – 46.0 dBμV/m = 69.14 dBc
High channel minimum delta = 114.45– 46.0 dBμV/m = 68.45 dBc

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



Marker 1 [T1] RBW 100 kHz RF Att 0 dB
 Ref Lvl -103.86 dBm VBW 300 kHz
 -35 dBm 610.62124248 MHz SWT 5 ms Unit dBm



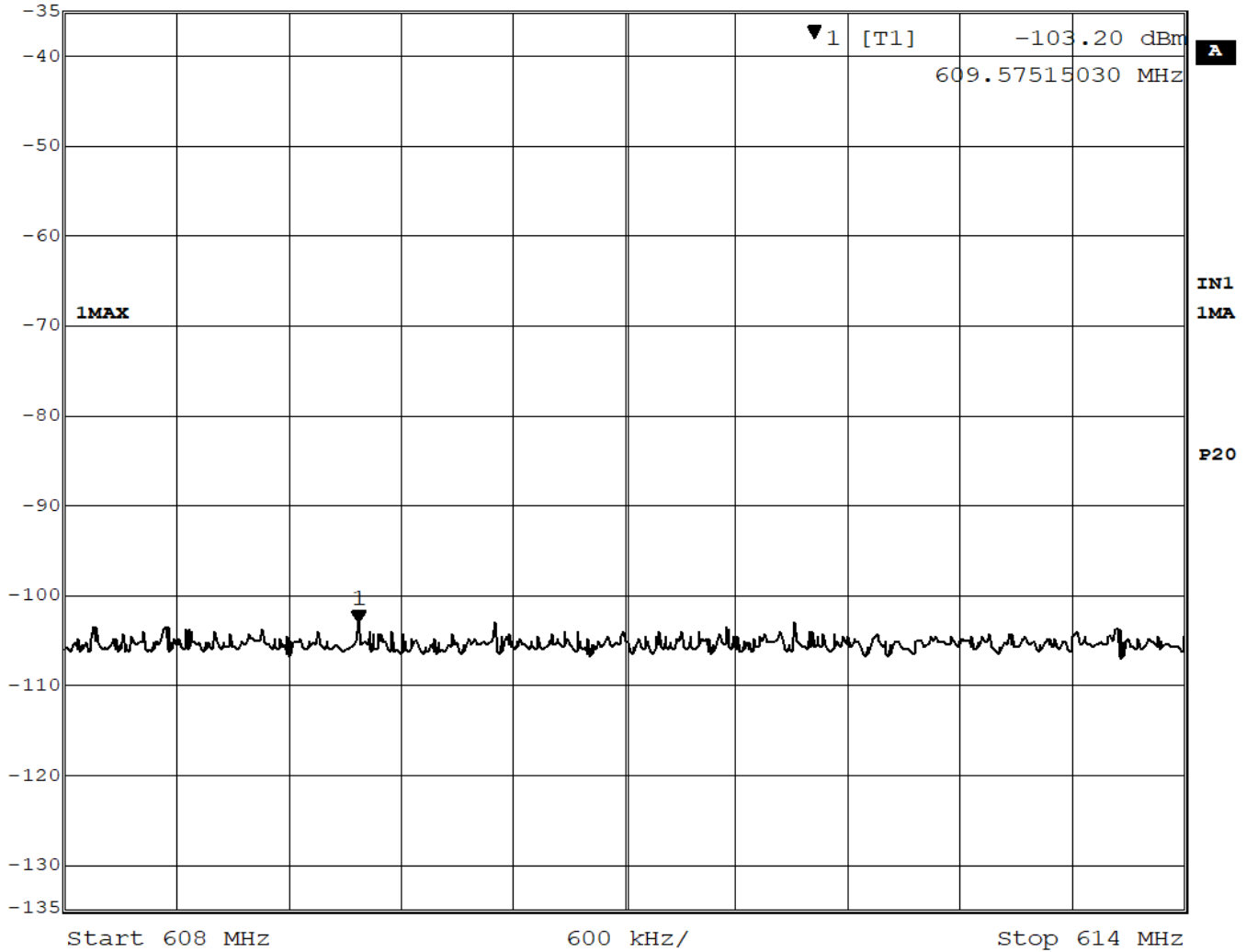
Date: 19.FEB.2019 12:02:34

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

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



Marker 1 [T1] RBW 100 kHz RF Att 0 dB
 Ref Lvl -103.20 dBm VBW 300 kHz
 -35 dBm 609.57515030 MHz SWT 5 ms Unit dBm



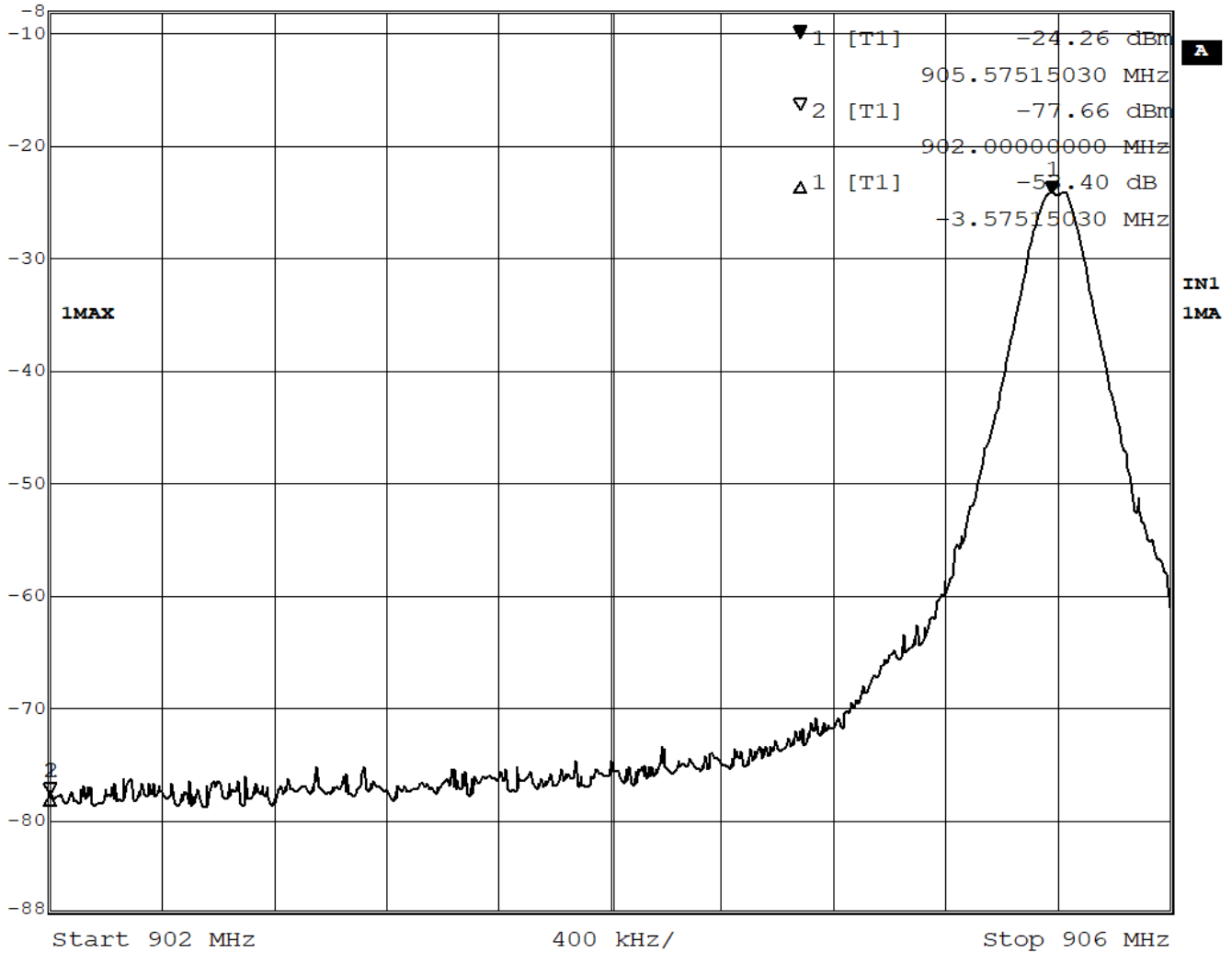
Date: 19.FEB.2019 08:21:34

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

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



Marker 1 [T1]	RBW	100 kHz	RF Att	10 dB
Ref Lvl	-24.26 dBm	VBW	300 kHz	
-8 dBm	905.57515030 MHz	SWT	5 ms	Unit dBm



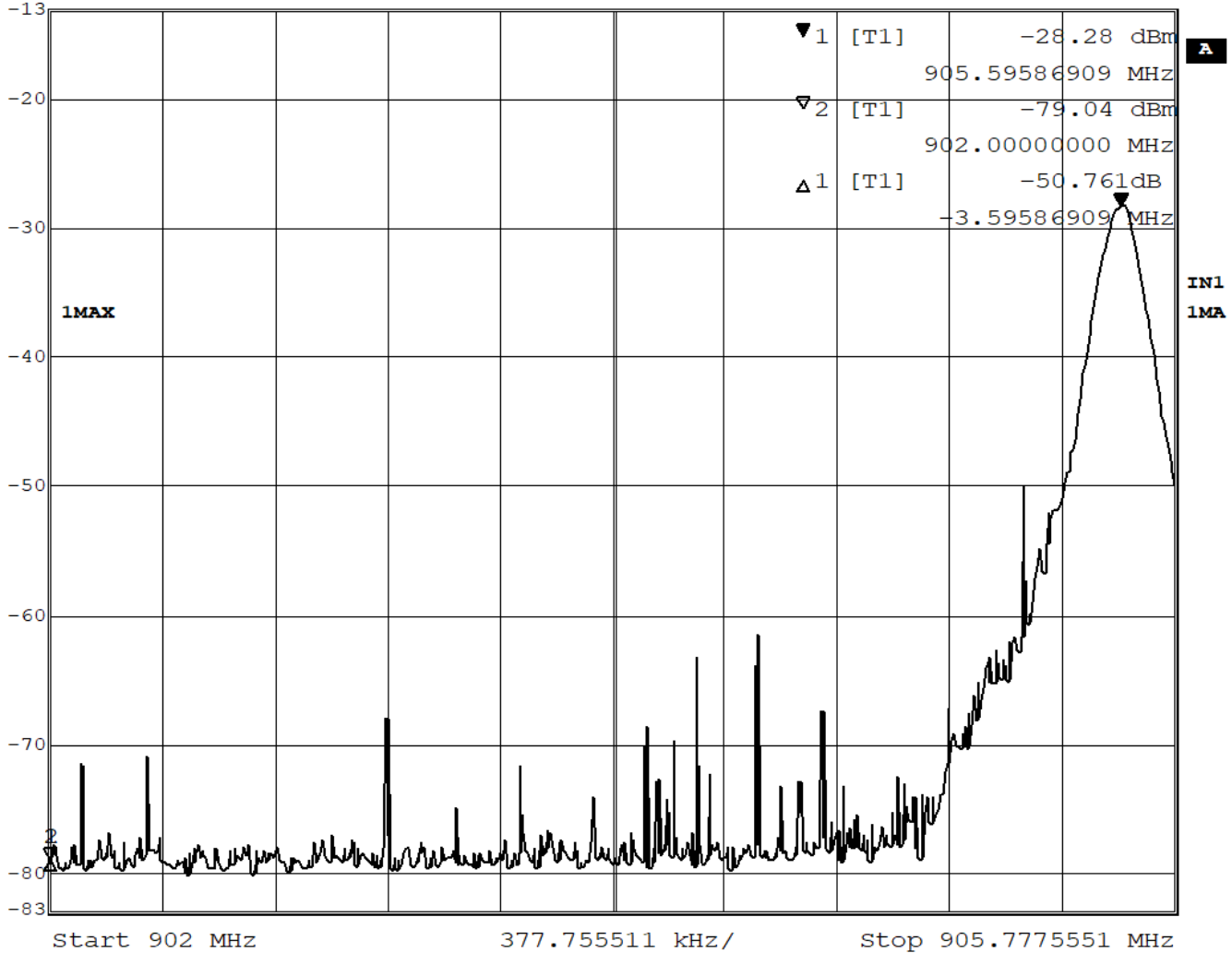
Date: 19.FEB.2019 12:04:47

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

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



Marker 1 [T1] RBW 100 kHz RF Att 10 dB
 Ref Lvl -28.28 dBm VBW 300 kHz
 -13 dBm 905.59586909 MHz SWT 5 ms Unit dBm



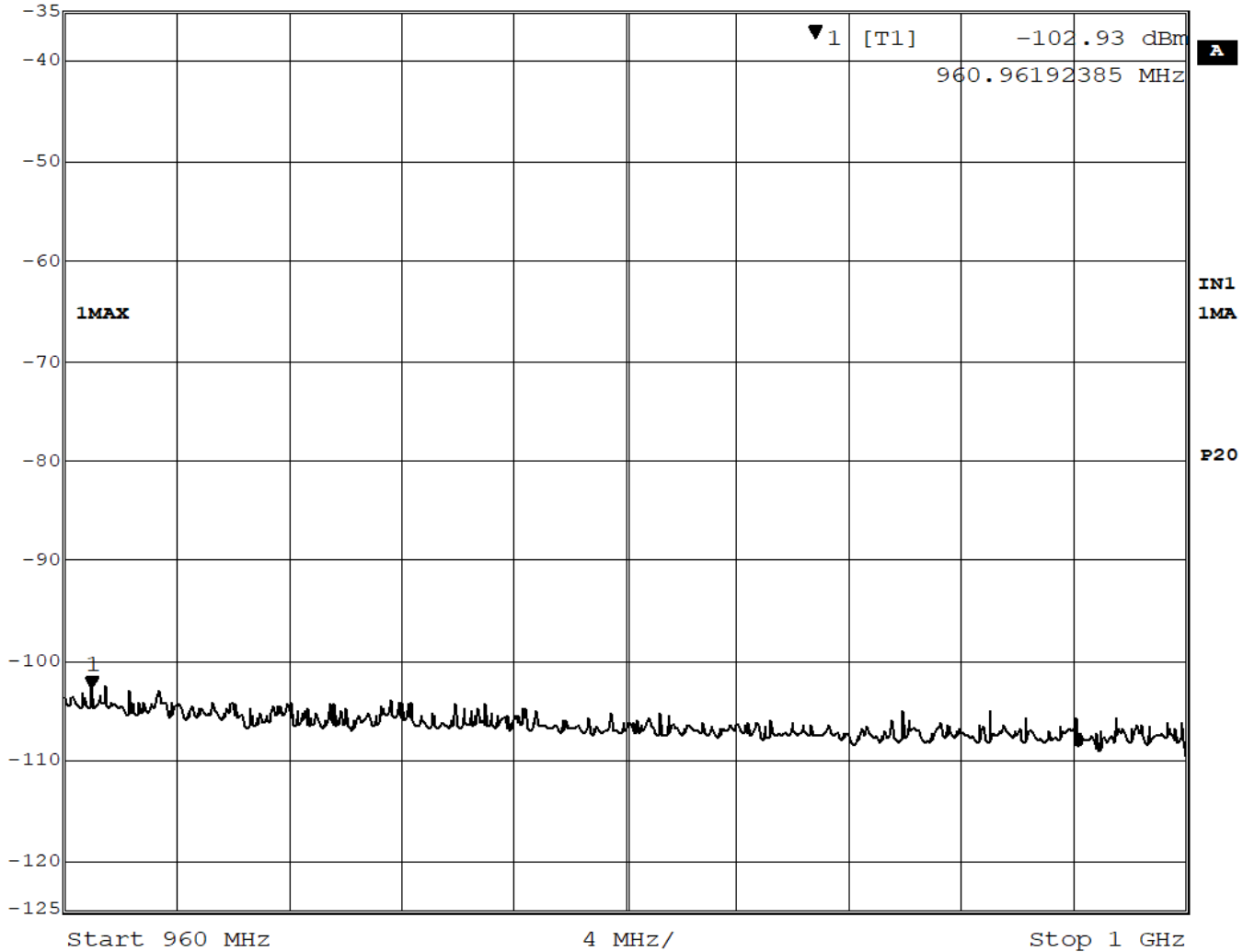
Date: 19.FEB.2019 08:25:03

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

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



Marker 1 [T1] RBW 100 kHz RF Att 0 dB
 Ref Lvl -102.93 dBm VBW 300 kHz
 -35 dBm 960.96192385 MHz SWT 10 ms Unit dBm



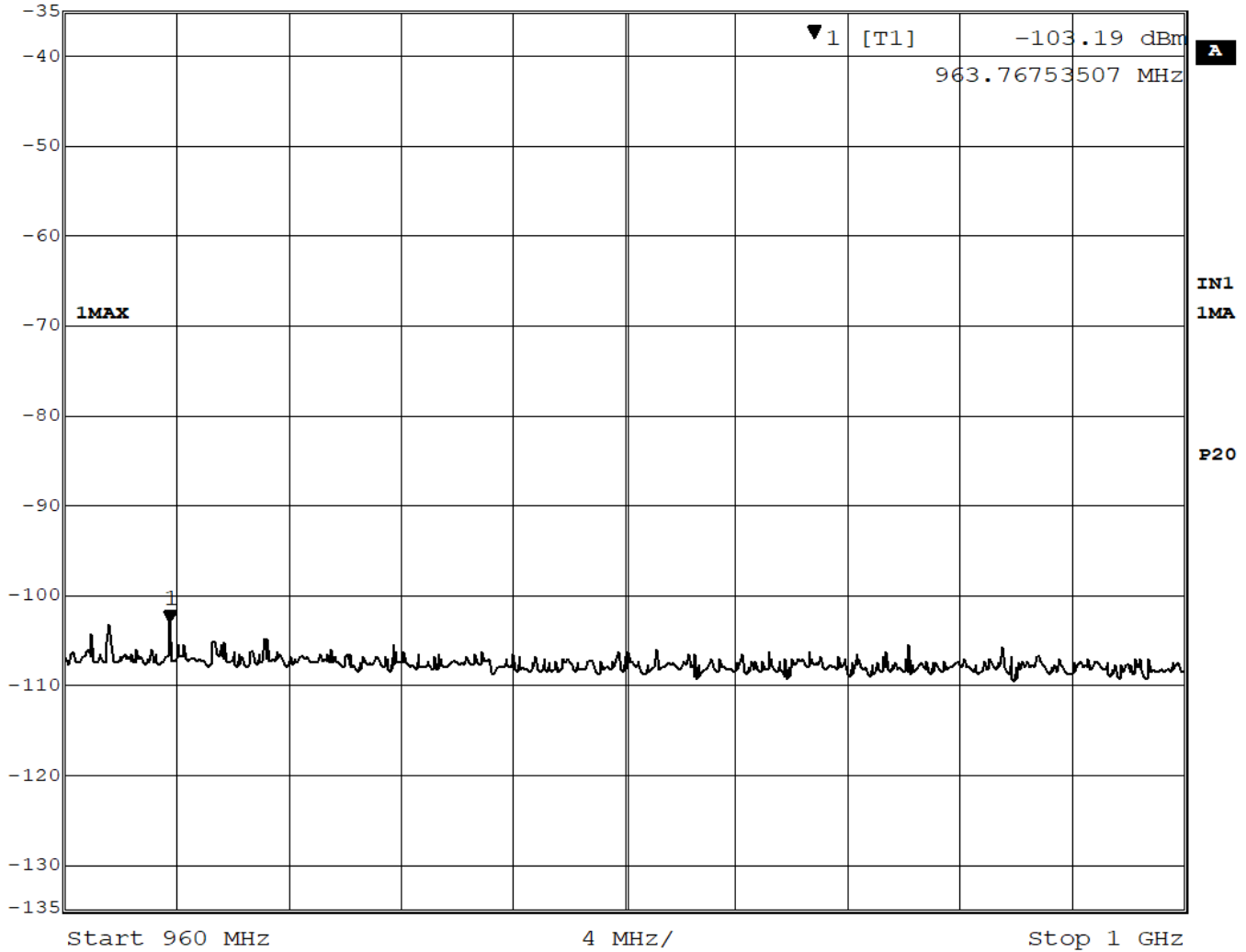
Date: 19.FEB.2019 10:59:03

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

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



Marker 1 [T1] RBW 100 kHz RF Att 0 dB
 Ref Lvl -103.19 dBm VBW 300 kHz
 -35 dBm 963.76753507 MHz SWT 10 ms Unit dBm



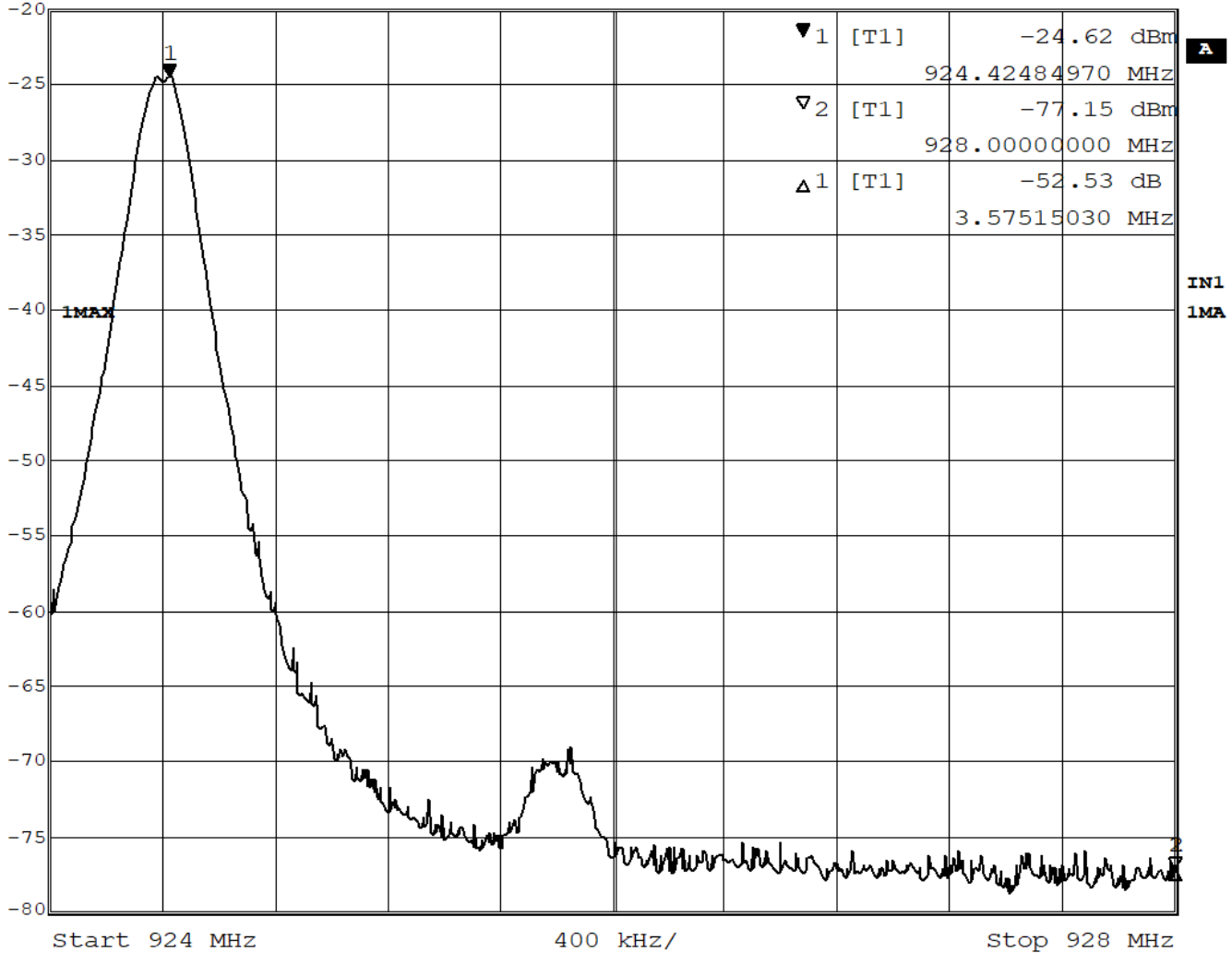
Date: 19.FEB.2019 08:17:44

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

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



Marker 1 [T1] RBW 100 kHz RF Att 10 dB
 Ref Lvl -24.62 dBm VBW 300 kHz
 -20 dBm 924.42484970 MHz SWT 5 ms Unit dBm



Date: 19.FEB.2019 10:36:01

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

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

Delta = 52.53 dB > 20 dB minimum



Marker 1 [T1] RBW 100 kHz RF Att 10 dB

Ref Lvl -30.71 dBm

VBW 300 kHz

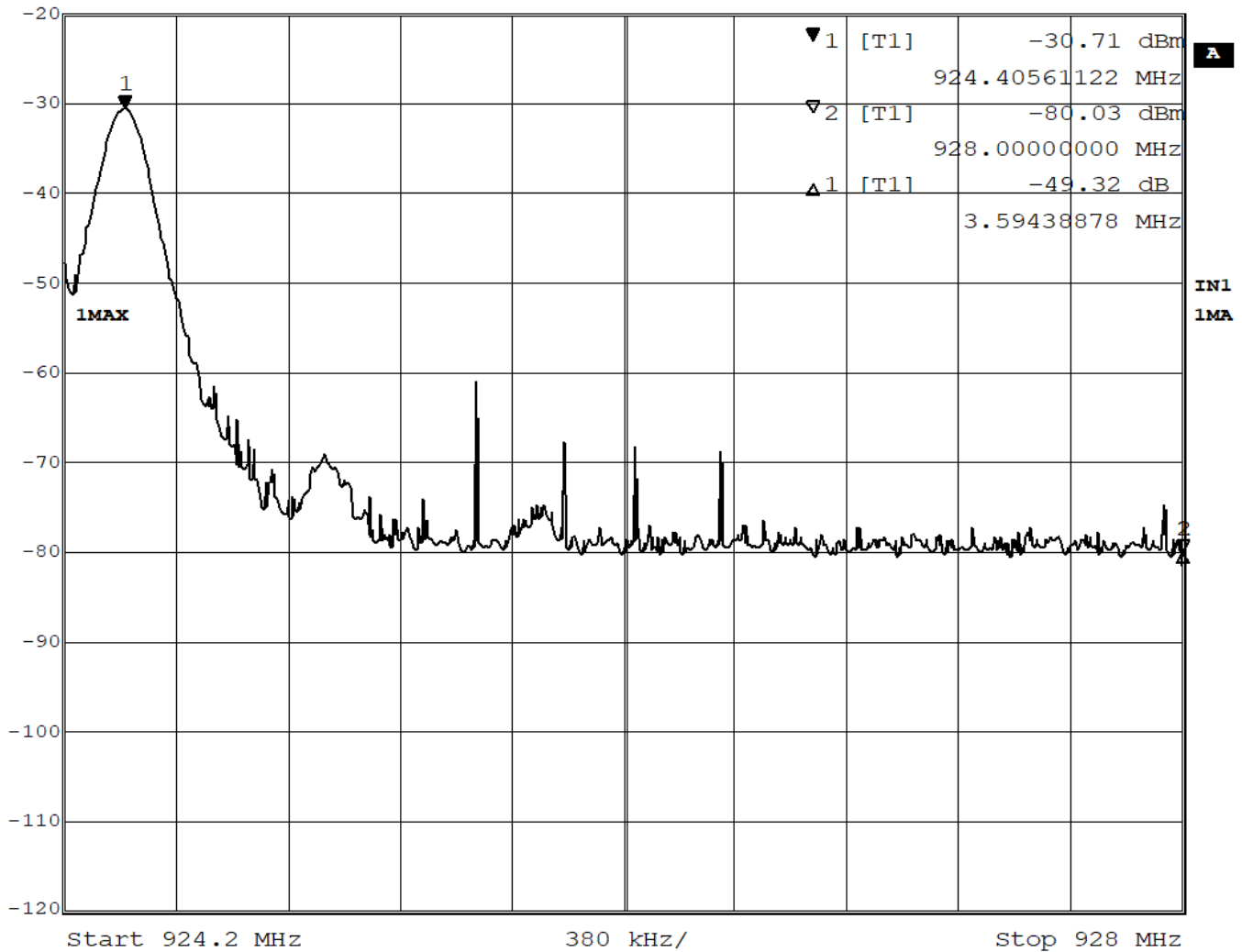
-20 dBm

924.40561122 MHz

SWT 5 ms

Unit

dBm



Date: 19.FEB.2019 08:16:19

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

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

Delta = 49.32 dB > 20 dB minimum



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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.

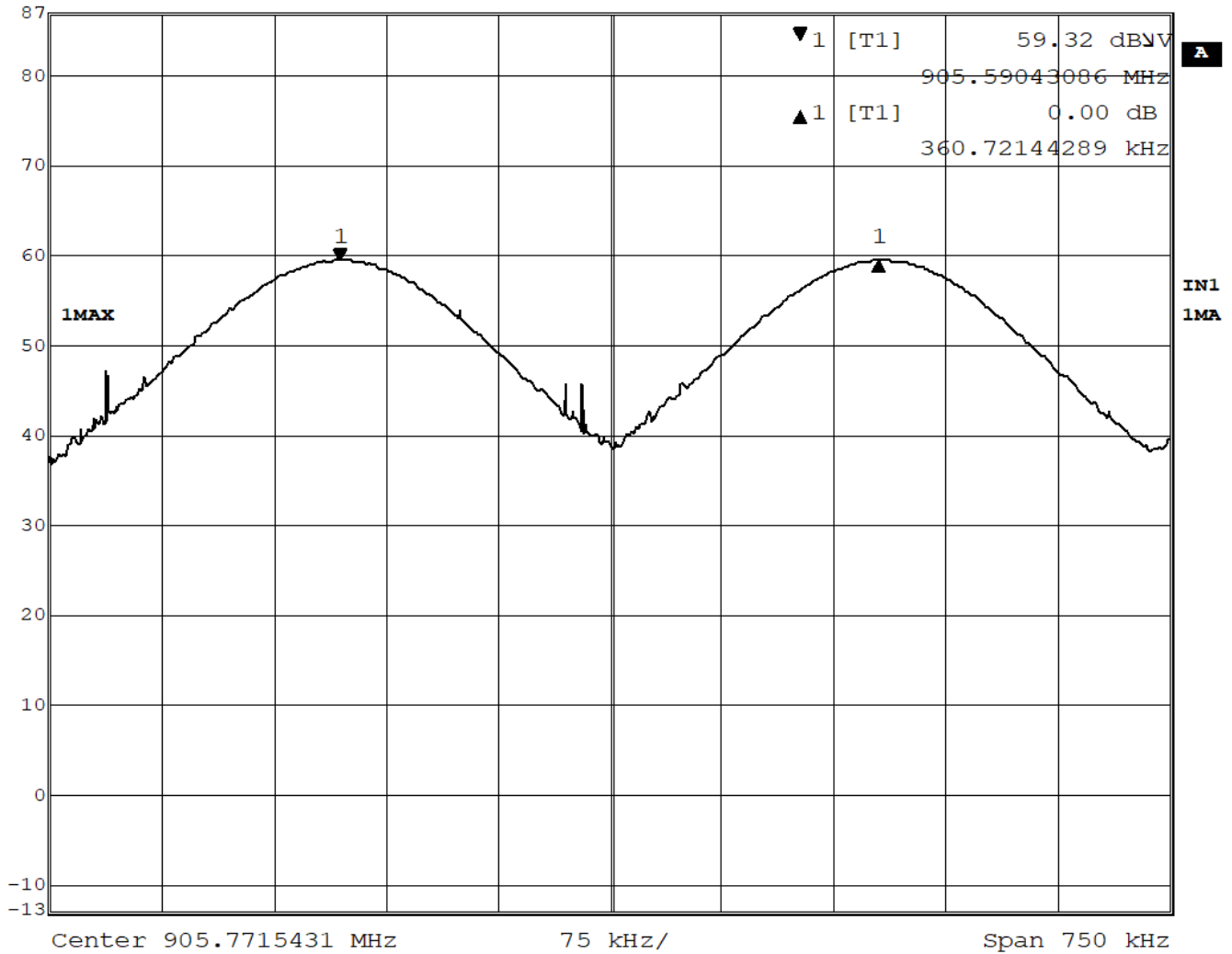
EUT operating conditions:

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:



Delta 1 [T1] RBW 100 kHz RF Att 10 dB
 Ref Lvl 0.00 dB VBW 300 kHz
 87 dBV 360.72144289 kHz SWT 5 ms Unit dBV

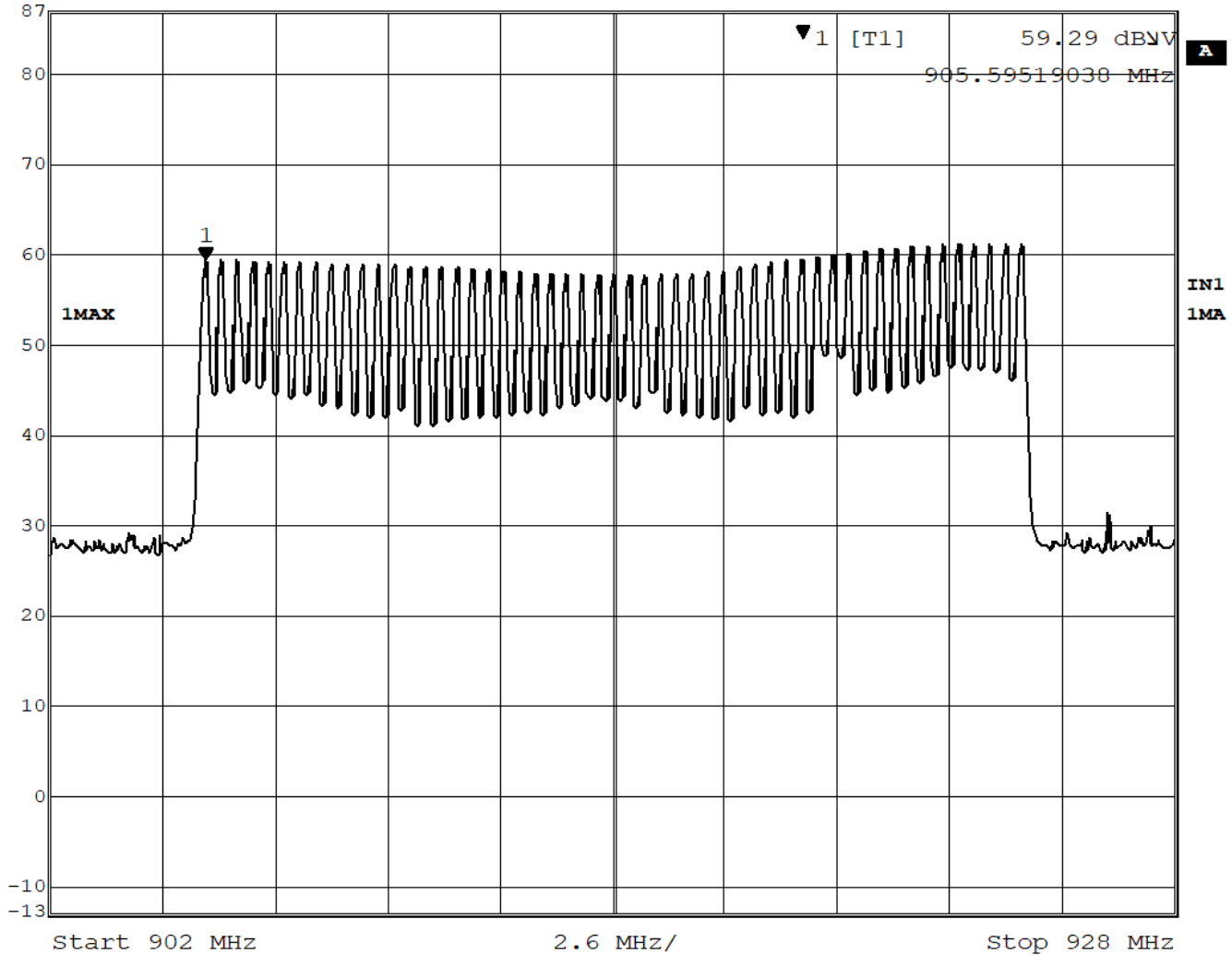


Date: 15.FEB.2019 07:25:58

Figure 25 – Frequency Separation



Marker 1 [T1] RBW 100 kHz RF Att 10 dB
 Ref Lvl 59.29 dBV VBW 100 kHz
 87 dBV 905.59519038 MHz SWT 6.5 ms Unit dBV

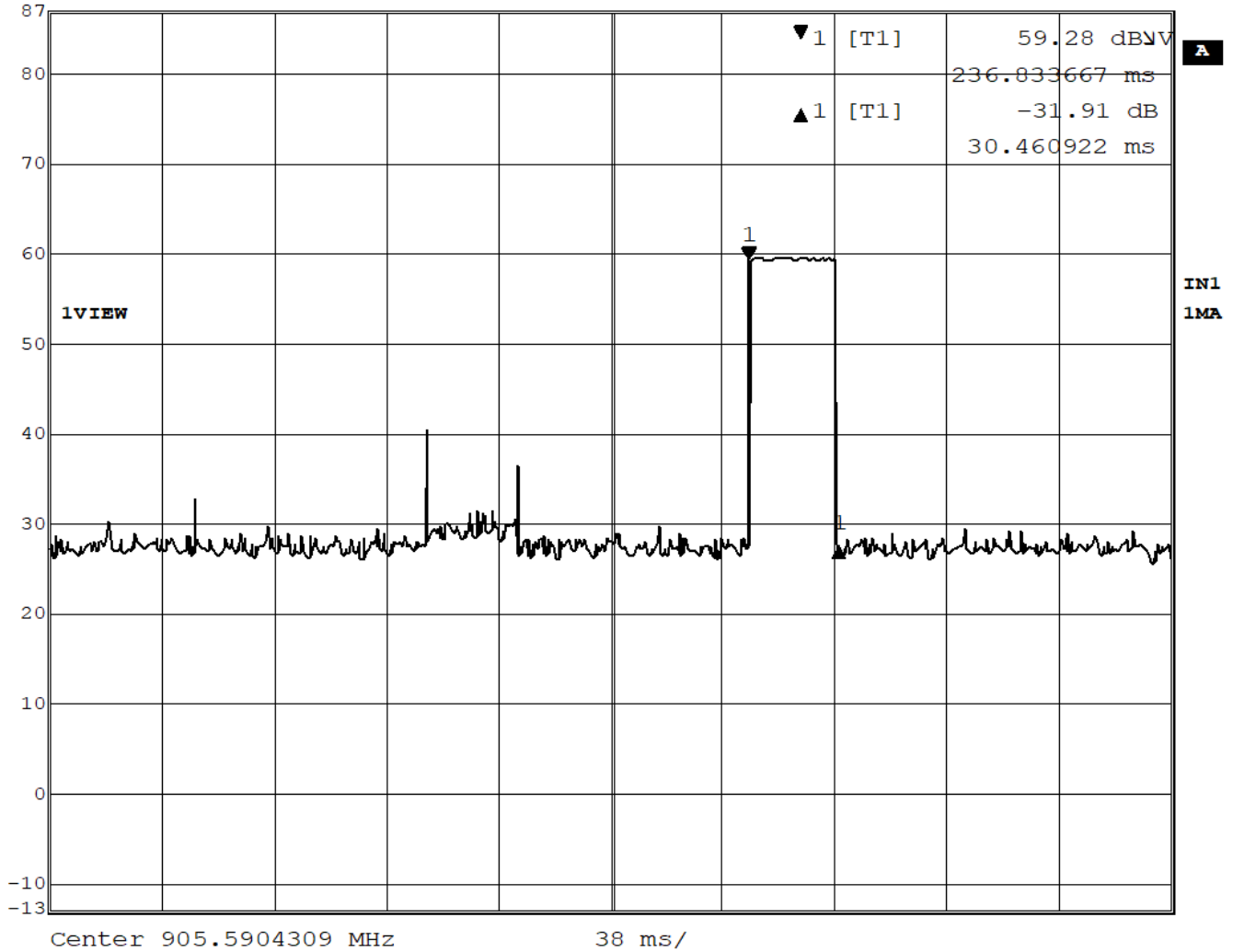


Date: 15.FEB.2019 07:23:15

Figure 26 – Hop Count, 53 Hops



Delta 1 [T1]	RBW	100 kHz	RF Att	10 dB
Ref Lvl	-31.91 dB	VBW	300 kHz	
87 dBV	30.460922 ms	SWT	380 ms	Unit dBV

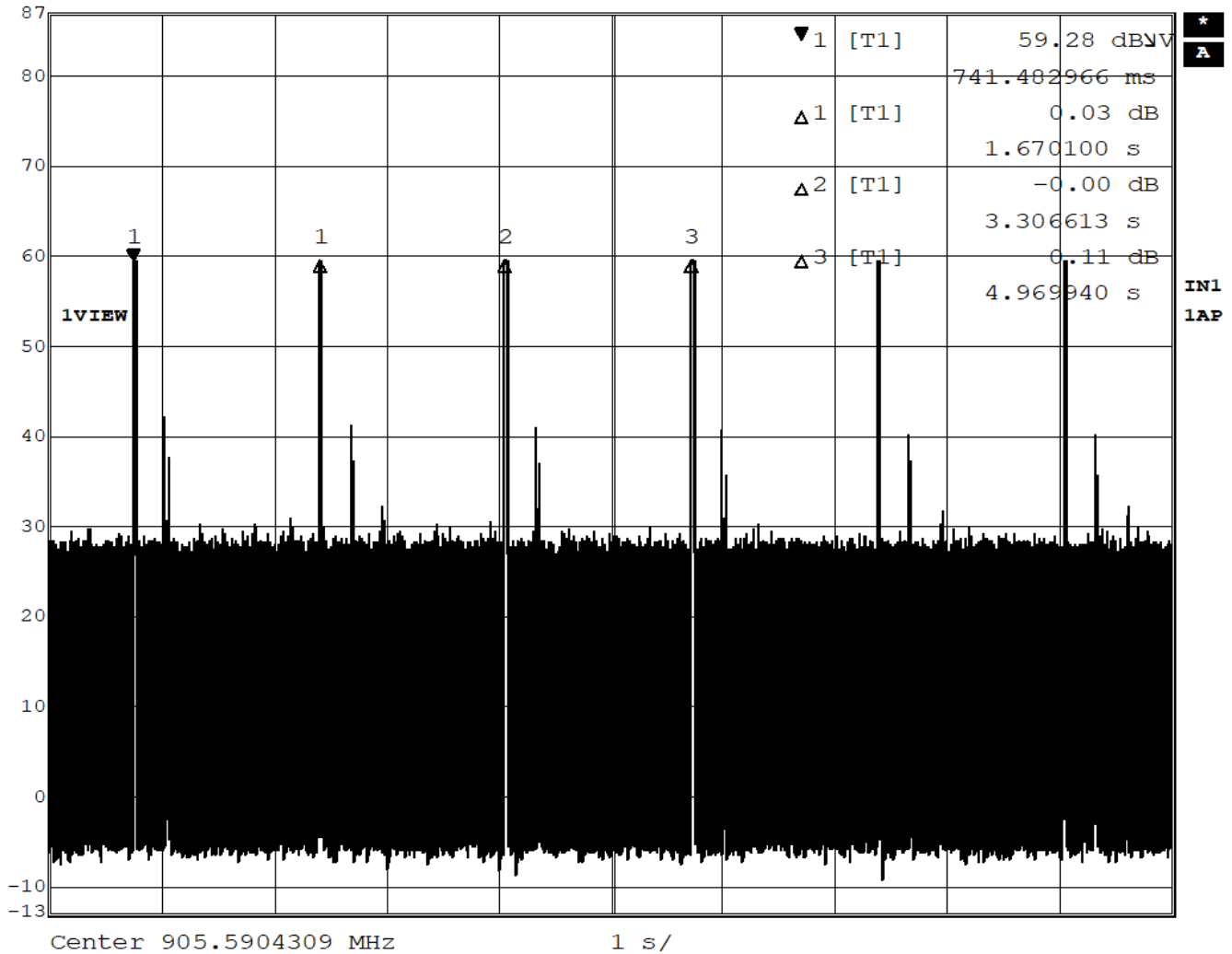


Date: 15.FEB.2019 07:28:07

Figure 27 – Time of Occupancy, On Time



Marker 1 [T1] RBW 100 kHz RF Att 10 dB
 Ref Lvl 59.28 dBµV VBW 300 kHz
 87 dBµV 741.482966 ms SWT 10 s Unit dBµV



Date: 15.FEB.2019 07:29:59

Figure 28 – Time of Occupancy, Period

*Maximum of 12 transmissions can occur in a given channel in any 20 s so the average time of occupancy is $30.46 \text{ ms} \times 12 = 365.52 \text{ ms} = 0.322 \text{ s} < 0.4 \text{ s}$ - Pass



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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 (dB μ V)	
	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

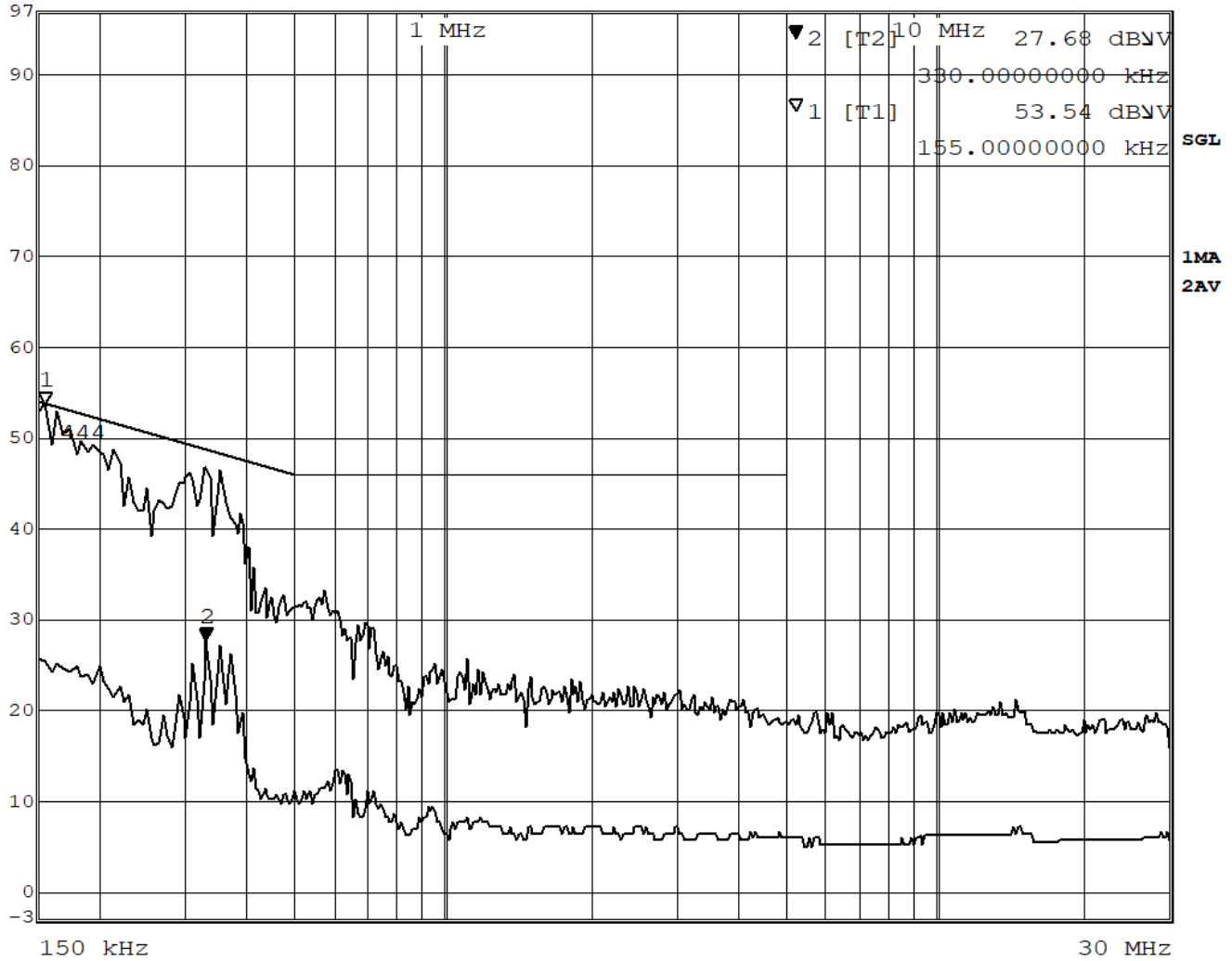
EUT operating conditions:

The EUT was powered by 12 VDC unless specified and set to transmit continuously on the lowest channel.

Test Results:



Marker 2 [T2]	Det	AV Trd	ES-K1
Att 10 dB AUTO	27.68 dBV	ResBW	9 kHz
INPUT 2	330.0000000 kHz	Meas T	100 ms Unit
			dBV



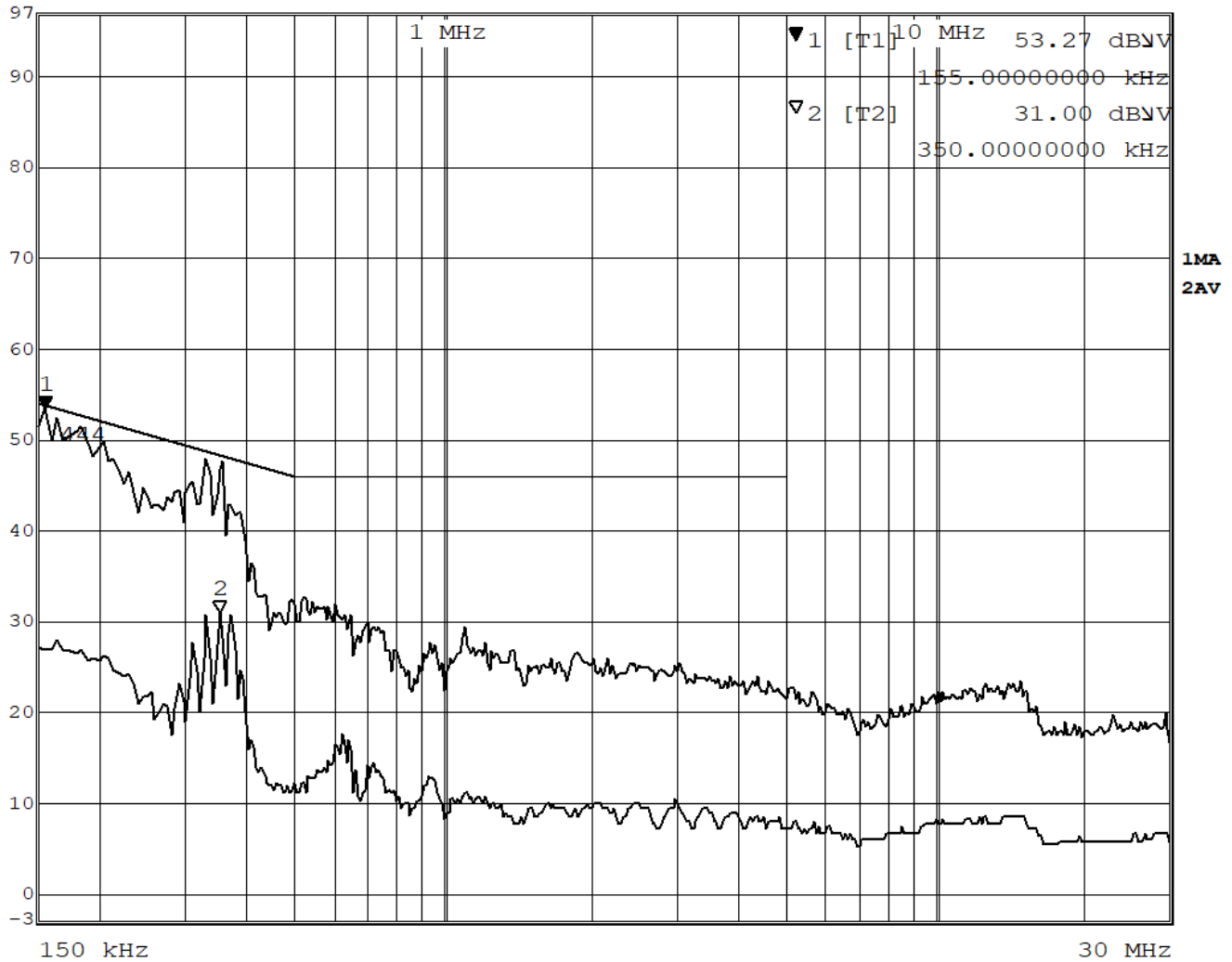
Date: 19.FEB.2019 15:00:55

Figure 29 – Conducted Emissions Plot, L-F

All measurements were found to be at least 10dB below the applicable limit.



Marker 1 [T1]	Det	AV Trd	ES-K1
Att 10 dB AUTO	53.27 dBV	ResBW 9 kHz	
INPUT 2	155.0000000 kHz	Meas T	100 ms Unit
			dBV



Date: 19.FEB.2019 15:35:36

Figure 30 – Conducted Emissions Plot, N-F

All measurements were found to be at least 10dB below the applicable limit.



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APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

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

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

where FS = Field Strength

- RA = Receiver Amplitude
- AF = Antenna Factor
- CF = Cable Attenuation Factor
- AG = Amplifier Gain
- AV = Averaging Factor (if applicable)


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

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

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

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

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

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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;

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

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

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

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

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

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

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

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

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



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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%.



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REPORT END