

Test Report

Radio Characteristics

Product	Wi-Fi handset		
Name and address of the applicant	Ascom Sweden AB P.O.Box 8783, SE-402 76 Gothenburg		
Name and address of the manufacturer	Ascom Sweden AB P.O.Box 8783, SE-402 76 Gothenburg		
Model	WH2		
Rating	3.7Vdc Battery		
Trademark	ASCOM		
Serial number	Radiated sample: T26060FH2 Conducted sample: 18AM39501350		
Additional information	This test report covers only radiated emissions of BLE and BT in the frequency band 2400 – 2483.5 MHz		
Tested according to	ETSI EN 300 328 v2.1.1 (2016-11) parts of Draft ETSI EN 300 328 v2.2.0 (2017-11) parts of		
Order number	362353		
Tested in period	2019-01-16 – 2019-01-29 and 2019-05-09		
Issue date	2019-05-10		
Name and address of the testing laboratory	Nemko Group Nemko AS Gaustadalléen 30, P.O.Box 73 Blindern, 0314 Oslo, Norway	Tel: +47 22 96 03 30 Fax: +47 22 96 05 50	 
An accredited technical test executed under the Norwegian accreditation scheme			
 Prepared by [G.Suhanthakumar]		 Approved by [Frode Sveinsen]	
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1 GENERAL INFORMATION

1.1 Test Information

Name :	Ascom
Model/version :	WH2
Serial number :	Radiated sample: T26060FH2 Conducted sample: 18AM39501350
Hardware identity and/or version :	PB
Software identity and/or version :	1.0.4_Nemko
Adaptivity:	N/A
Frequency Range :	2402 - 2480 MHz
Number of Channels :	BLE: 40 BT: 79
Channel Spacing :	2 MHz
Operating Mode :	Transceiver
Type of Modulation :	BLE :GFSK, 250kHz deviation BT : GFSK, 8DPSK, $\pi/4$ -DQPSK
Rated Output Power :	BLE: < 10 dBm (Radiated) BT:< 20 dBm (Radiated)
Power supply :	Battery 3.7Vdc
Antenna Connector :	N/A
Number of Antennas :	1
Antenna Diversity Supported :	N/A
Smart Antenna System :	No
Receiver category:	2
Geo-Location capability:	Not implemented

Description of Tested Device(s)

The tested equipment is a Wi-fi handset with following radio technologies, BLE, BT, 2.4GHz wi-fi, and 5GHz wi-fi.

1.2 Test Environment

1.2.1 *Normal test condition*

Temperature:	20.0 – 23 °C
Relative humidity:	20.0 – 44.0 %
Normal test voltage:	3.7Vdc

The values are the limit registered during the test period.

1.2.2 *Extreme test conditions*

Not tested

1.3 Test Engineer

G.Suhandhakumar

1.4 Test Equipment

See list of test equipment in clause 8.

1.5 Other Comments

The EUT has been tested radiated spurious emissions according to ETSI EN 300 328 and tests are passed.
The power setting is maximum.

2 TEST REPORT SUMMARY

2.1 General

The tests were conducted on a sample of the equipment for demonstrating compliance with

ETSI EN 300 328 V2.1.1 (2016-11):

Wideband Transmission systems; Data transmission equipment operating in the 2.4 GHz ISM band and using wide band modulation techniques; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

DRAFT ETSI EN 300 328 V2.2.0 (2017-11):

Wideband Transmission systems; Data transmission equipment operating in the 2.4 GHz band and using wide band modulation techniques; Harmonised Standard for access to radio spectrum

The test methods have been in accordance with TM-NO-WLS-500, TM-NO-WLS-204A and EN 300 328 where applicable.

Radiated tests were performed in accordance with TM-NO-WLS-500, TM-NO-WLS-204A and EN 300 328. Radiated emissions are made in a 3m anechoic chamber.

Production Unit

Pre-production Unit



THIS TEST REPORT APPLIES ONLY TO THE ITEM(S) AND CONFIGURATIONS TESTED.

Deviations from, additions to, or exclusions from the test specifications are described in "Summary of Test Data".

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3 Test Report Summary

3.1 Abbreviations

The following abbreviations are used in the test summary:

- Pass** The test results are inside the limits given in EN 300328.
- Fail** The test results are outside the limits given in EN 300328.
- N/A** Not applicable. The testcase is not applicable for the tested equipment.
- N/T** Not tested. The testcase is not covered by this test report.
- U** Unconditional.
- C** Conditional.

3.2 Test Summary

Harmonized Standard EN 300 328					
Technical Requirement reference		Technical Requirement Conditionality		Test Specification	
Description	Reference Clause No	U/C	Condition	Reference Clause No	Verdict
RF Output Power	4.3.1.2 or 4.3.2.2	U		5.4.2	Pass
Power Spectral Density	4.3.2.3	C	Only for modulations other than FHSS	5.4.3	N/T
Duty cycle, Tx-Sequence, Tx-gap	4.3.1.3 or 4.3.2.4	C	Only for non-adaptive equipment	5.4.2	N/T
Accumulated Transmit time, Frequency Occupation & Hopping Sequence	4.3.1.4	C	Only for FHSS	5.4.4	N/T
Hopping Frequency Separation	4.3.1.5	C	Only for FHSS	5.4.5	N/T
Medium Utilisation	4.3.1.6 or 4.3.2.5	C	Only for non-adaptive equipment	5.4.2	N/T
Adaptivity	4.3.1.7 or 4.3.2.6	C	Only for adaptive equipment	5.4.6	N/A
Occupied Channel Bandwidth	4.3.1.8 or 4.3.2.7	U		5.4.7	N/T
Transmitter unwanted emissions in the Out-of-Band domain	4.3.1.9 or 4.3.2.8	U		5.4.8	N/T
Transmitter unwanted emissions in the spurious domain	4.3.1.10 or 4.3.2.9	U		5.4.9	Pass
Receiver spurious emissions	4.3.1.11 or 4.3.2.9	U		5.4.10	Pass
Receiver Blocking	4.3.1.12 or 4.3.2.11	U		5.4.11	N/T
Geo-Location capability	4.3.1.13 or 4.3.2.12	C	If Implemented	X	N/A ²

²: Not implemented. NT: Not required by the client (Wi-fi module pre-tested, Test report number from TUV Rheinland 50132219 001)

4 Test Results

4.1 RF Output Power, Radiated

ETSI EN 300 328 subclause 4.3.2.2

BLE mode:

Channel Frequency/Polarization	Measured e.i.r.p values (dBm)		
	XY plane	XZ Plane	YZ Plane
2402 MHz/HP	6.76	-1.08	4.67
2402 MHz/VP	-9.34	5.92	-1.33
2440 MHz/HP	6.55	-1.62	3.94
2440 MHz/VP	-12.79	5.78	-1.44
2480 MHz/HP	7.41	-0.07	3.64
2480 MHz/VP	-10.88	5.38	-2.80
Measurement Uncertainty U ₉₅	+1.6 / -1.8 dB		

BT mode:

Channel Frequency/Polarization	Measured e.i.r.p values (dBm)					
	XY plane		XZ Plane		YZ Plane	
	DH1	3-DH1	DH1	3-DH1	DH1	3-DH1
2402 MHz/HP	9.78	8.92	2.87	0.57	7.91	6.95
2402 MHz/VP	-6.46	-7.67	9.10	8.32	0.85	0.07
2440 MHz/HP	9.24	8.16	/	/	/	/
2440 MHz/VP	-14.72	-10.90	/	/	/	/
2480 MHz/HP	10.44	8.89	/	/	/	/
2480 MHz/VP	-7.74	-9.05	/	/	/	/
Measurement Uncertainty U ₉₅	+1.6 / -1.8 dB					

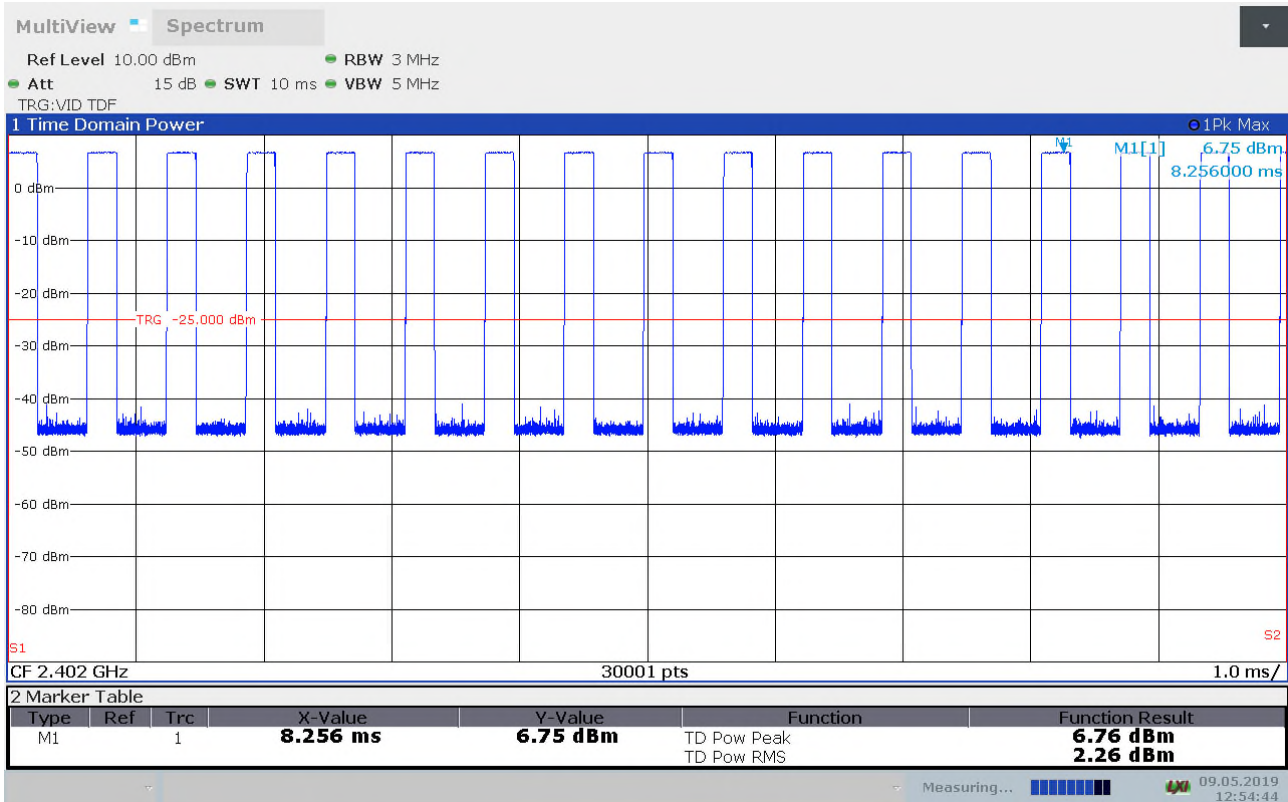
Measured both with PK detector and RMS detector. only PK values of e.i.r.p are given in the table above, The Maximum eirp is obtained in horizontal polairazation & XY plane.

Graphs for XY horizontal polarization is given below

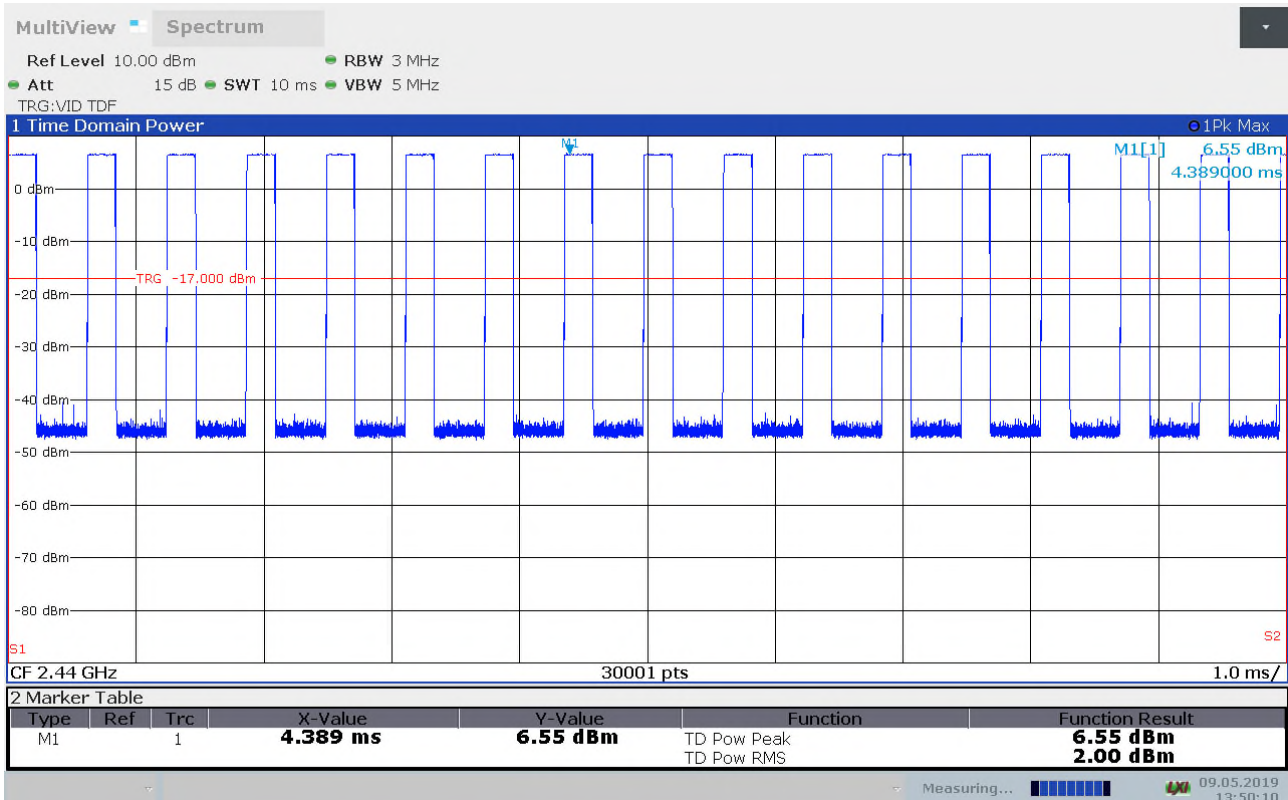
Limits: Clause 4.3.2.2.3

Maximum Effective Radiated Power shall be less than or equal to 100 mW (20 dBm) e.i.r.p.

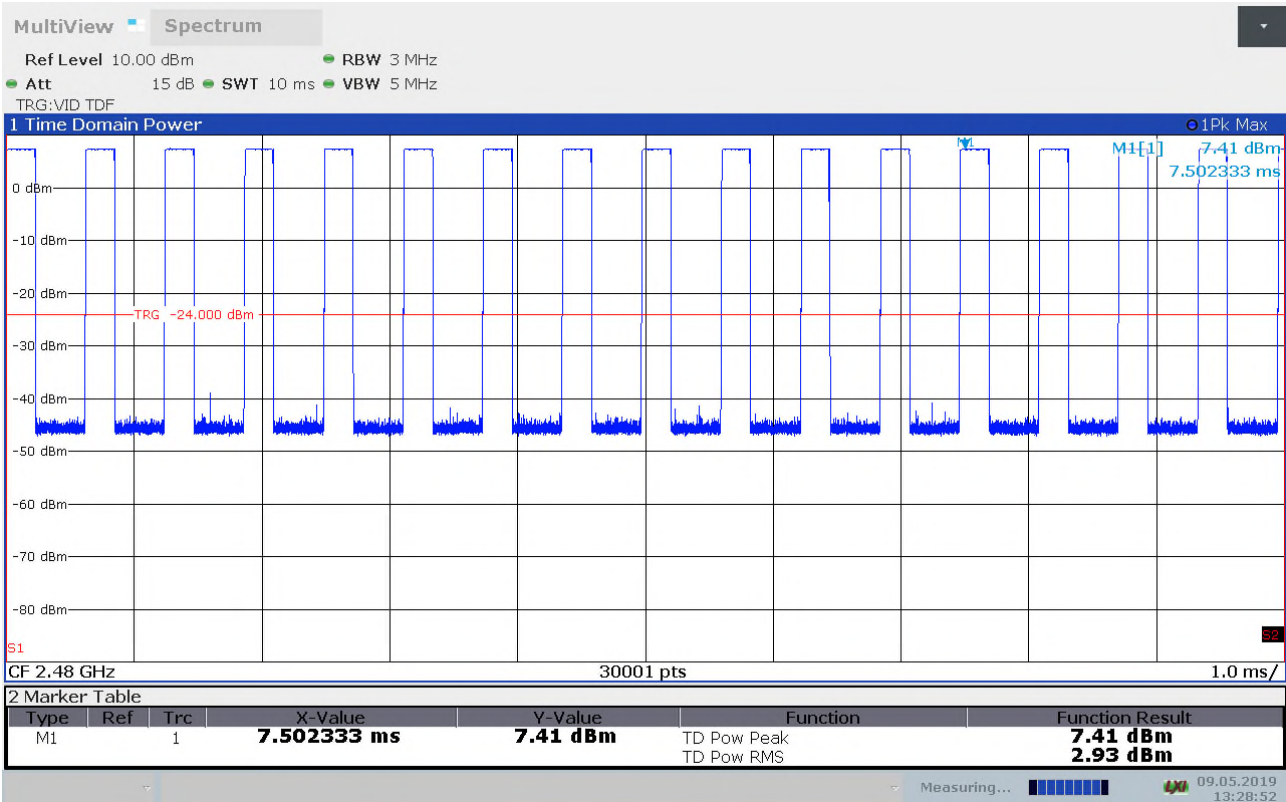
Test Equipment Used: 2,6



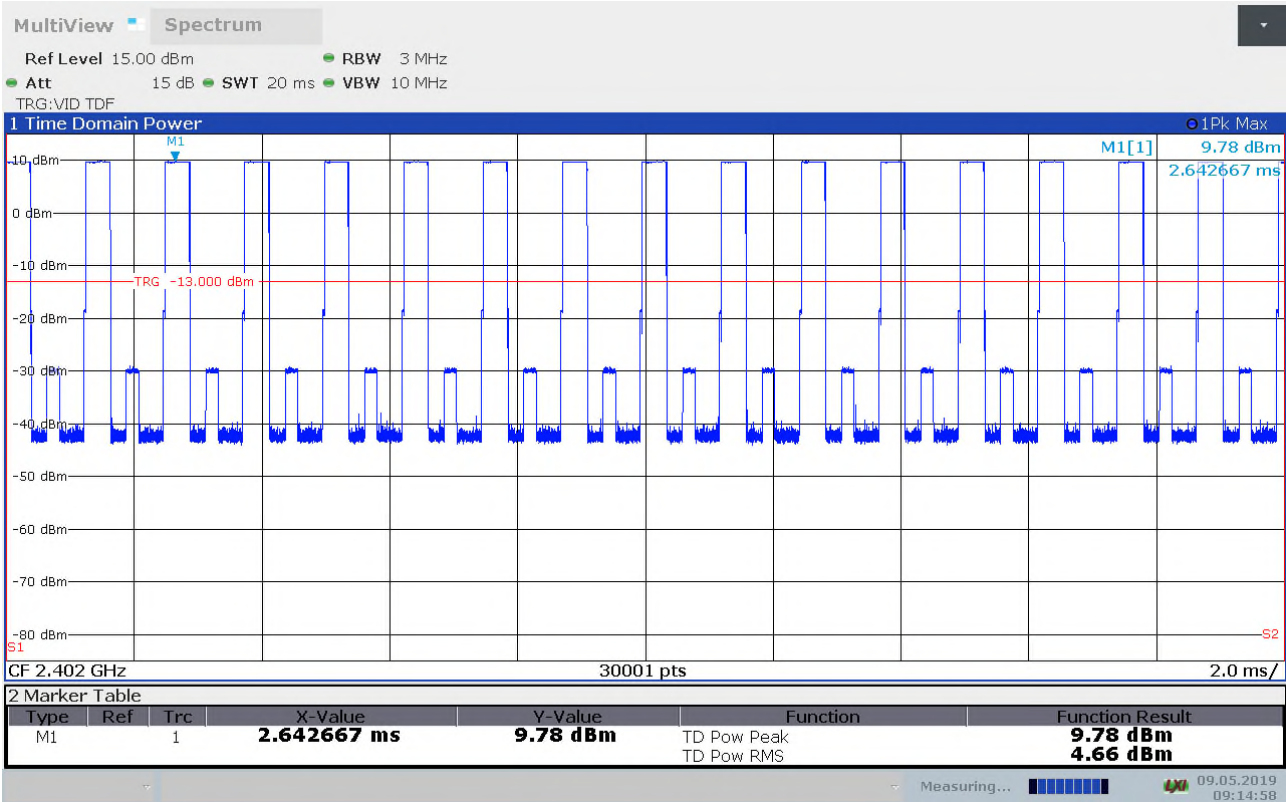
BLE mode: e.i.r.p , HP, XY plane , ch2402MHz



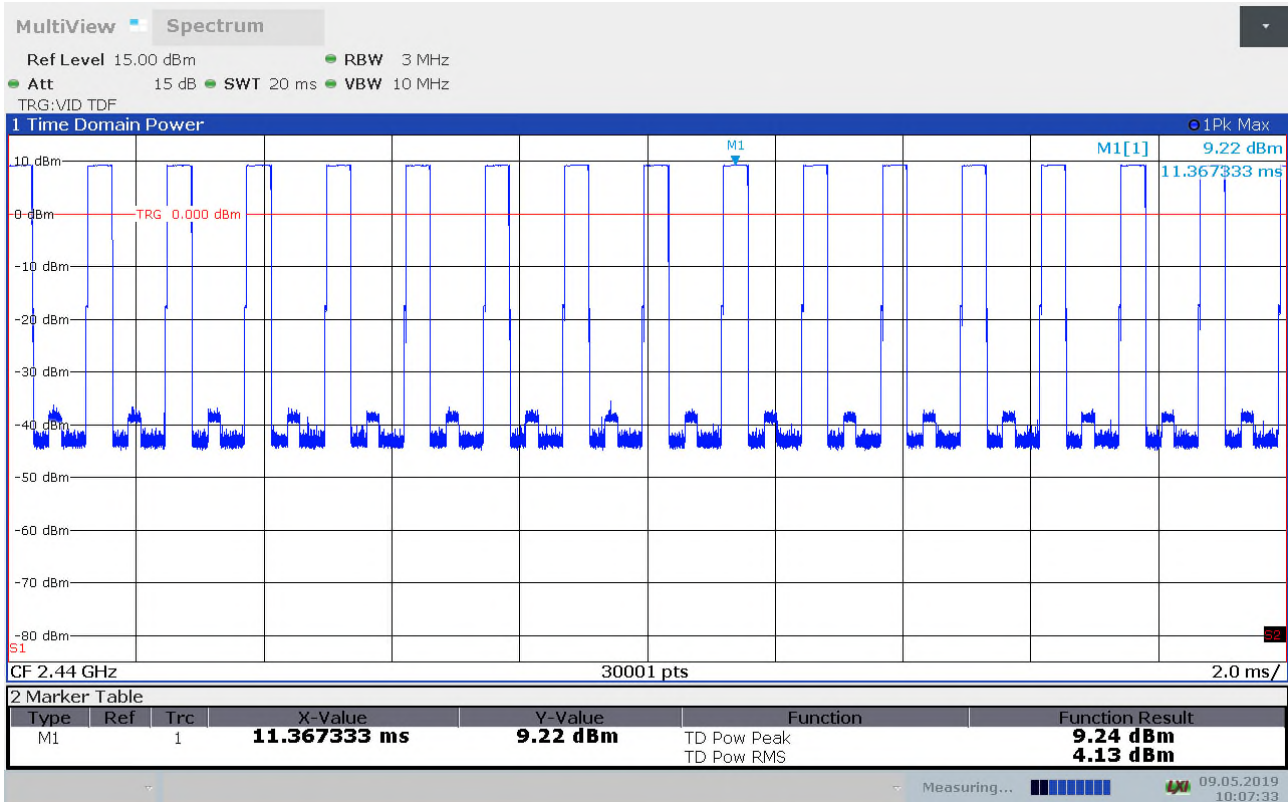
BLE mode: e.i.r.p , HP, XY plane , ch2440MHz



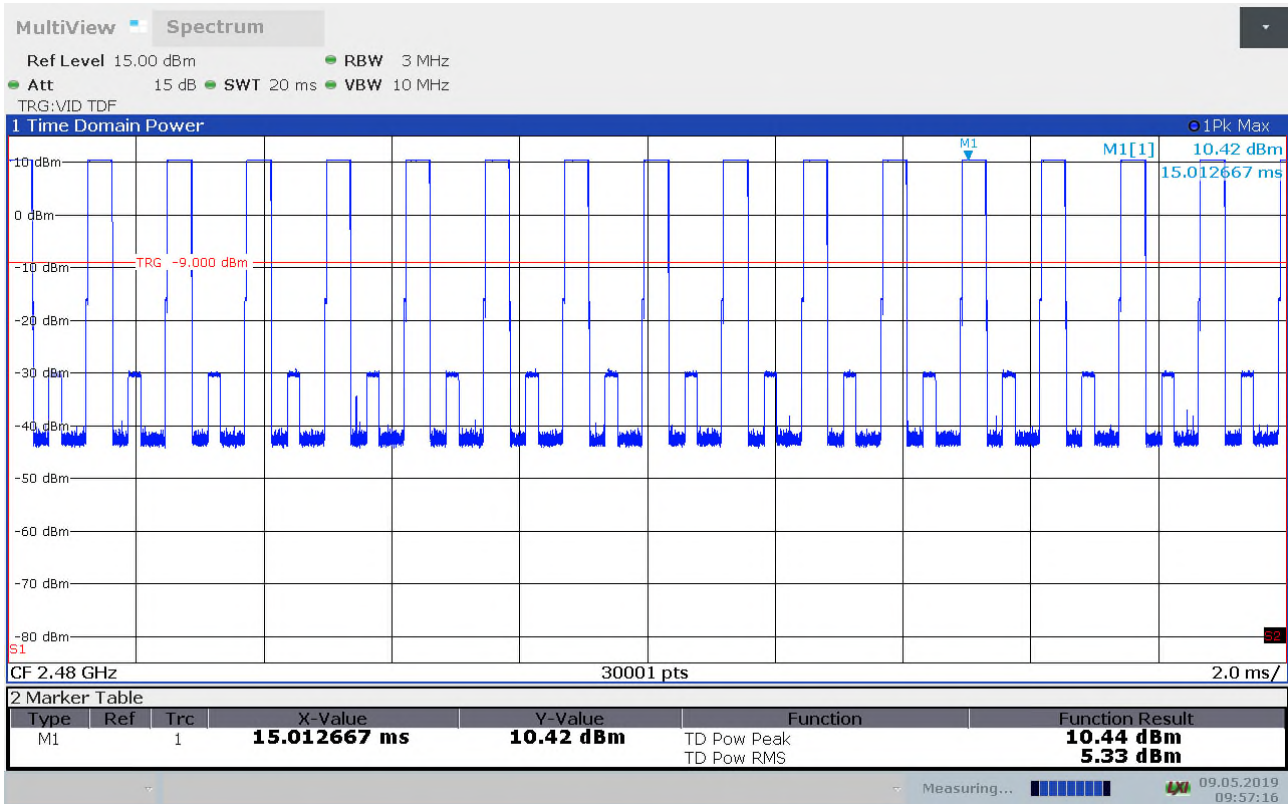
BLE mode: e.i.r.p , HP, XY plane , ch2480MHz



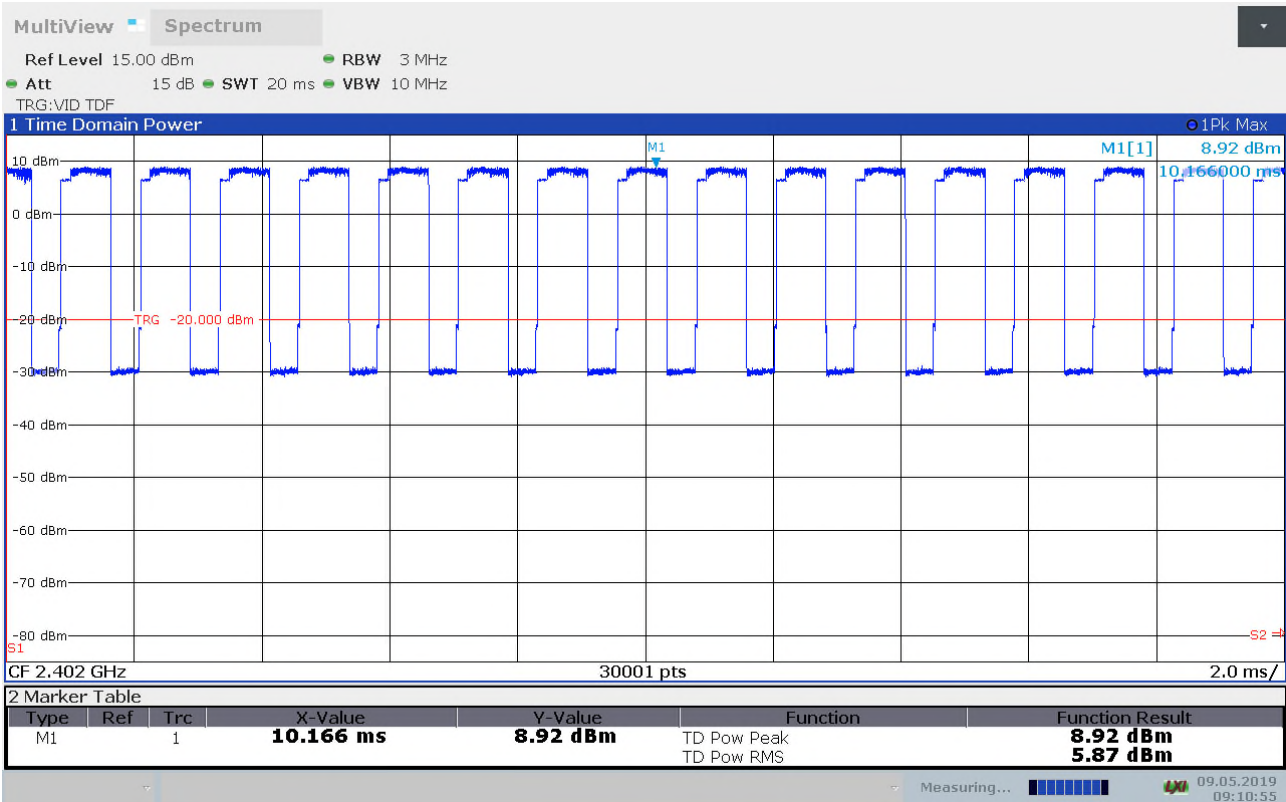
BT/DH1 mode: e.i.r.p , HP, XY plane , ch2402MHz



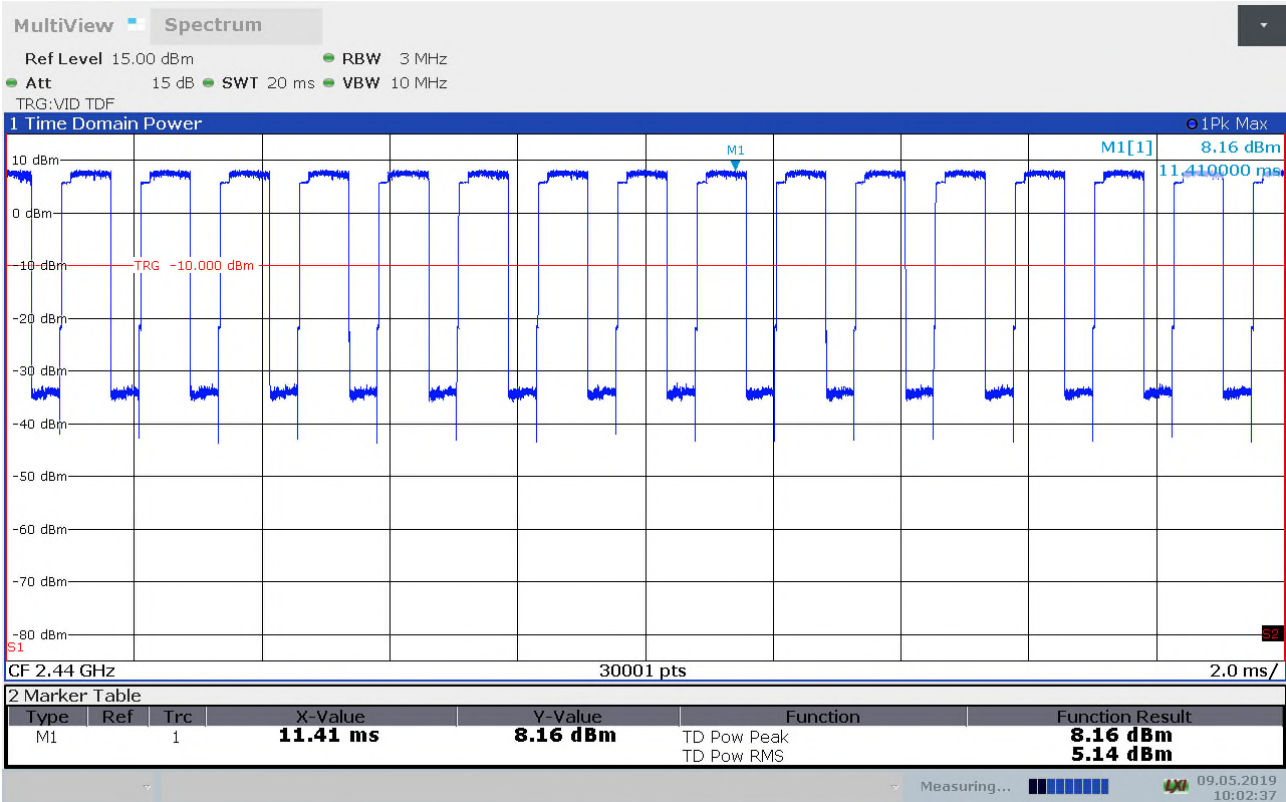
BT/DH1 mode: e.i.r.p , HP, XY plane , ch2440MHz



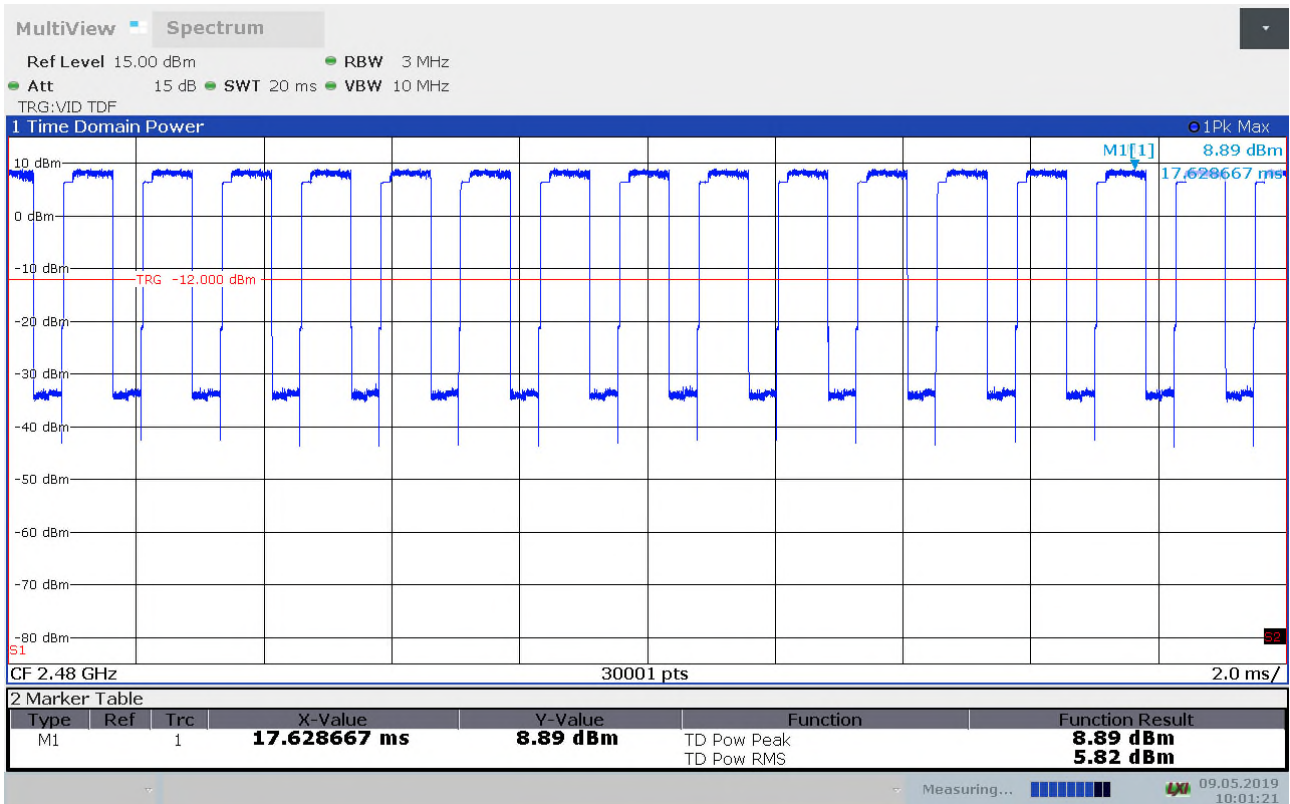
BT/DH1 mode: e.i.r.p , HP, XY plane , ch2480MHz



BT/3-DH1 mode: e.i.r.p , HP, XY plane , ch2402MHz



BT/3-DH1 mode: e.i.r.p , HP, XY plane , ch2440MHz



BT/3-DH1 mode: e.i.r.p , HP, XY plane , ch2480MHz

4.2 Transmitter spurious emissions - Radiated (Operating) - BLE

ETSI EN 300 328 subclause 4.3.2.9

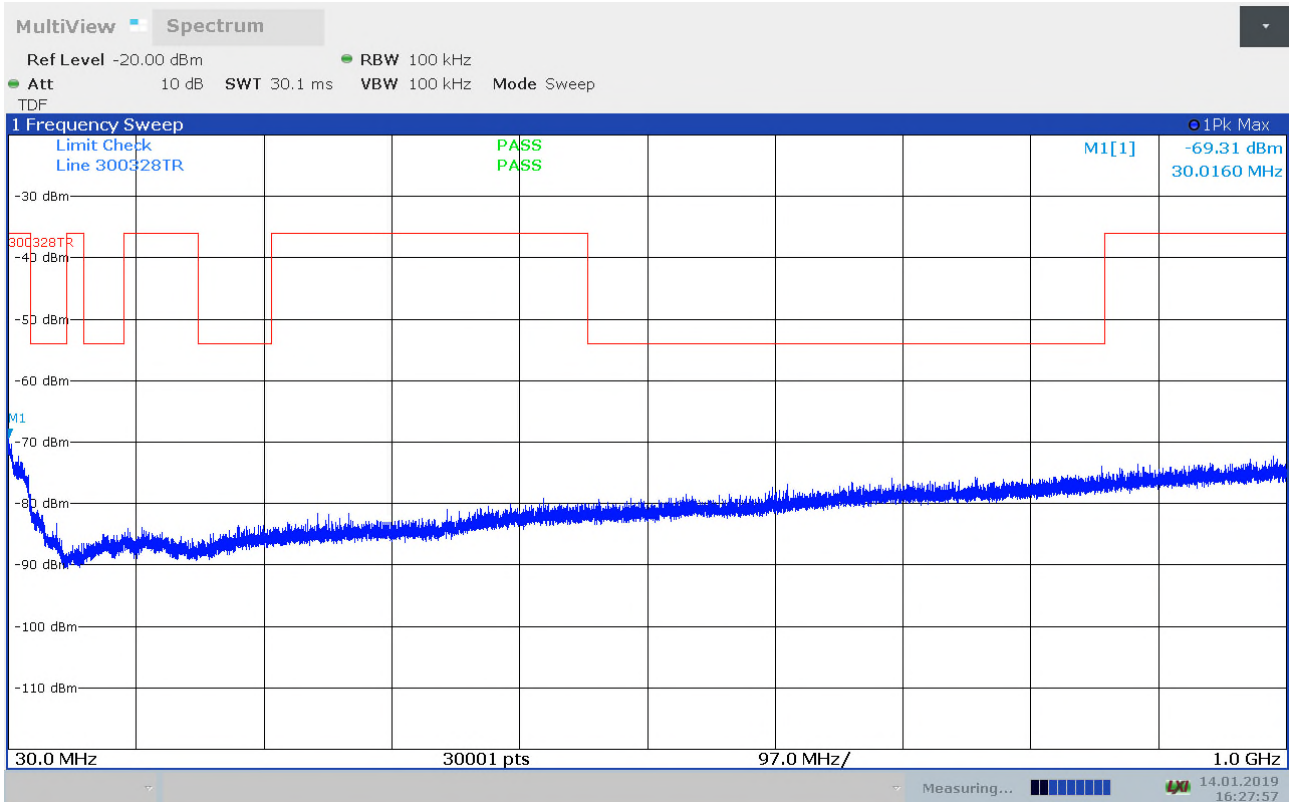
BLE

Frequency (MHz)	Detector	Polarization	Spurious Emission Level (dBm)
30 – 1000 (all others)	PK	VP/HP	< -54/-36
1000 – 12750 (all others)	PK	VP/HP	< -30
Measurement uncertainty			$\leq 2\text{GHz} - \pm 1.1 \text{ dB}$ $2\text{GHz} - 18 \text{ GHz} - \pm 2.0 \text{ dB}$

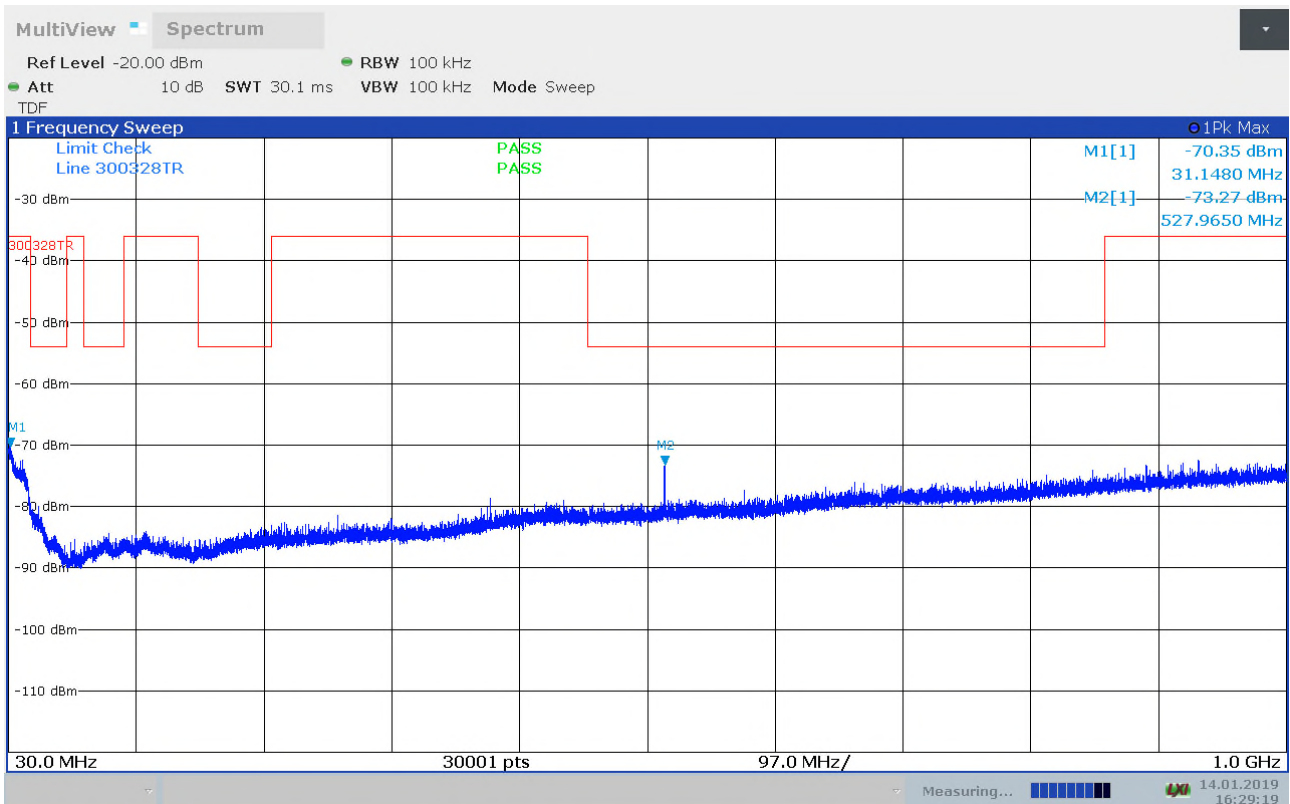
Limits: Clause 4.3.2.9.3

Frequency Range	Maximum power e.r.p. ($\leq 1 \text{ GHz}$) e.i.r.p. ($> 1 \text{ GHz}$)	Bandwidth
30 MHz to 47 MHz	-36 dBm	100 kHz
47 MHz to 74 MHz	-54 dBm	100 kHz
74 MHz to 87.5 MHz	-36 dBm	100 kHz
87.5 MHz to 118 MHz	-54 dBm	100 kHz
118 MHz to 174 MHz	-36 dBm	100 kHz
174 MHz to 230 MHz	-54 dBm	100 kHz
230 MHz to 470 MHz	-36 dBm	100 kHz
470 MHz to 862 MHz	-54 dBm	100 kHz
862 MHz to 1 GHz	-36 dBm	100 kHz
1 GHz to 12.75 GHz	-30 dBm	1 MHz

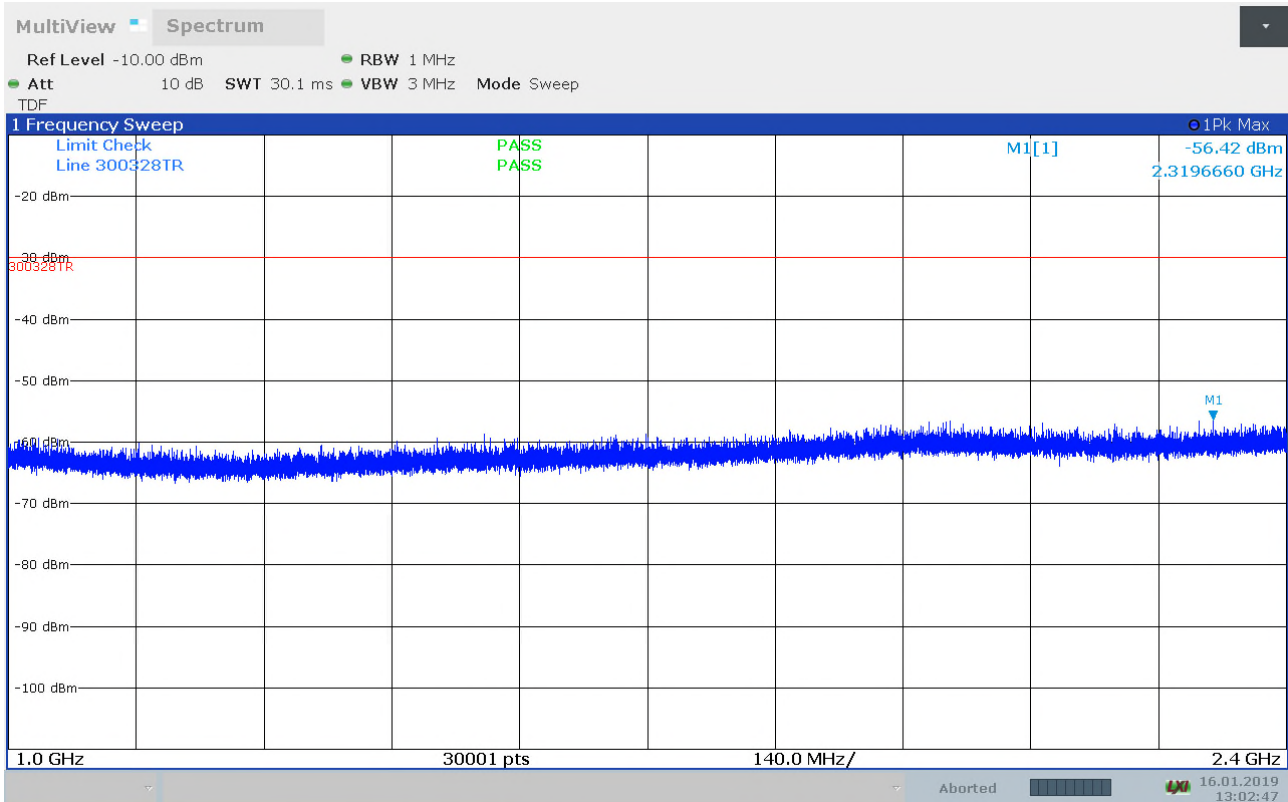
Test Equipment Used: 7,9,10,11,12,13



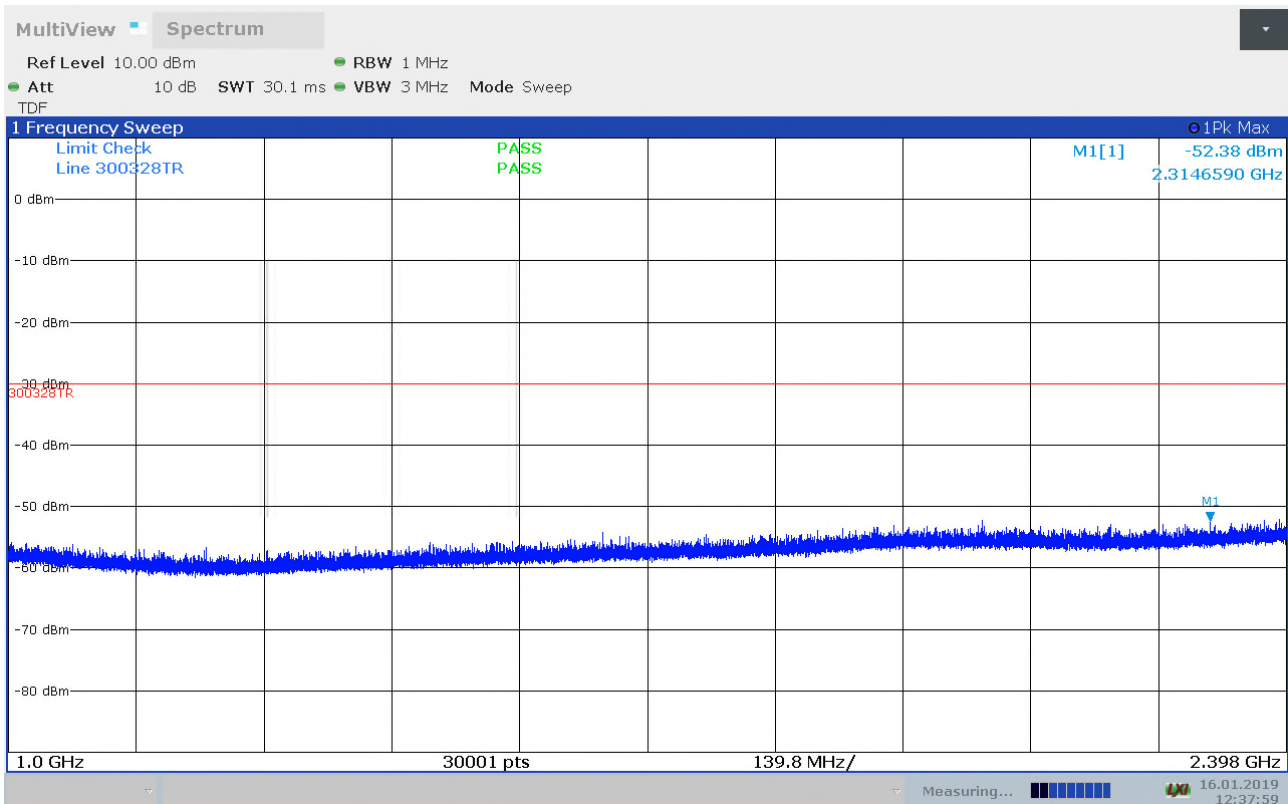
Radiated Emissions, 30 -1000MHz, HP



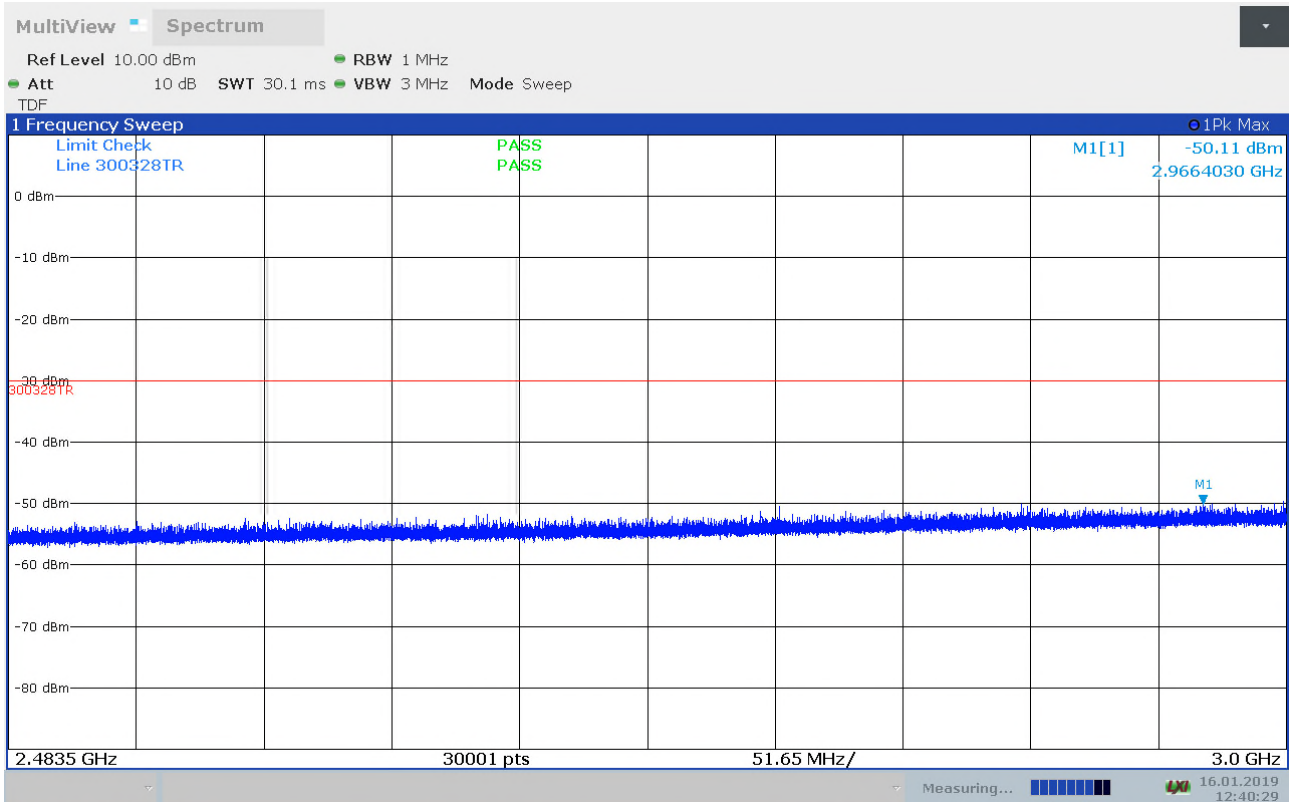
Radiated Emissions, 30 -1000MHz, VP



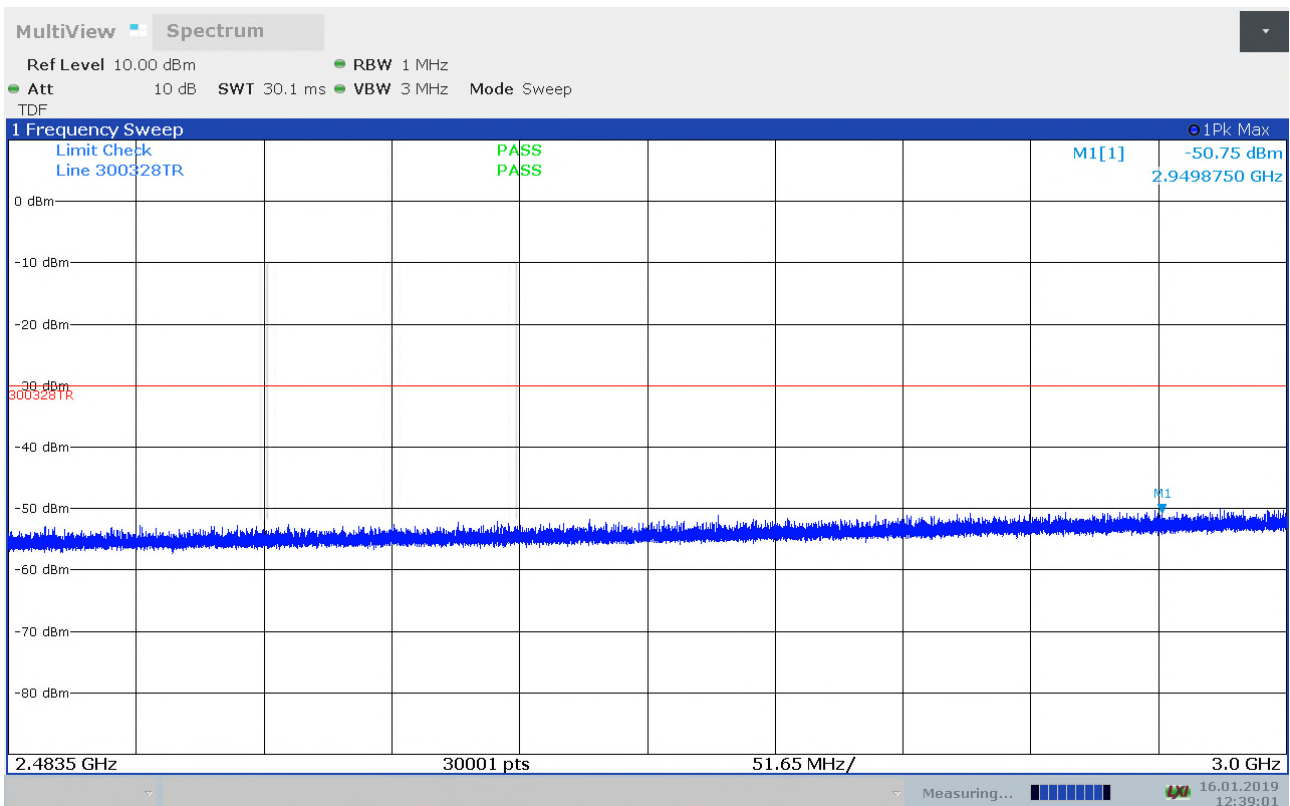
Radiated Emissions, 1 - 2.4GHz, 2402MHz, HP



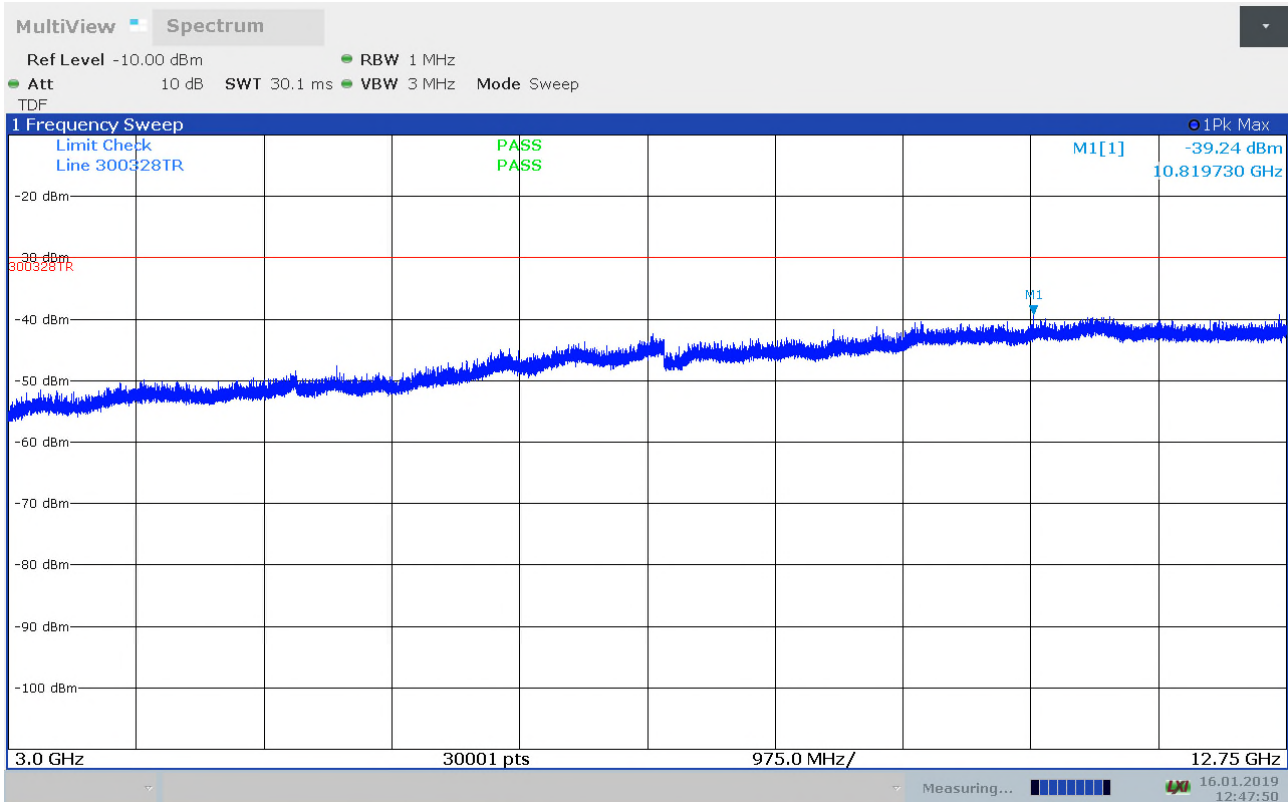
Radiated Emissions, 1 - 2.4GHz, 2402MHz, VP



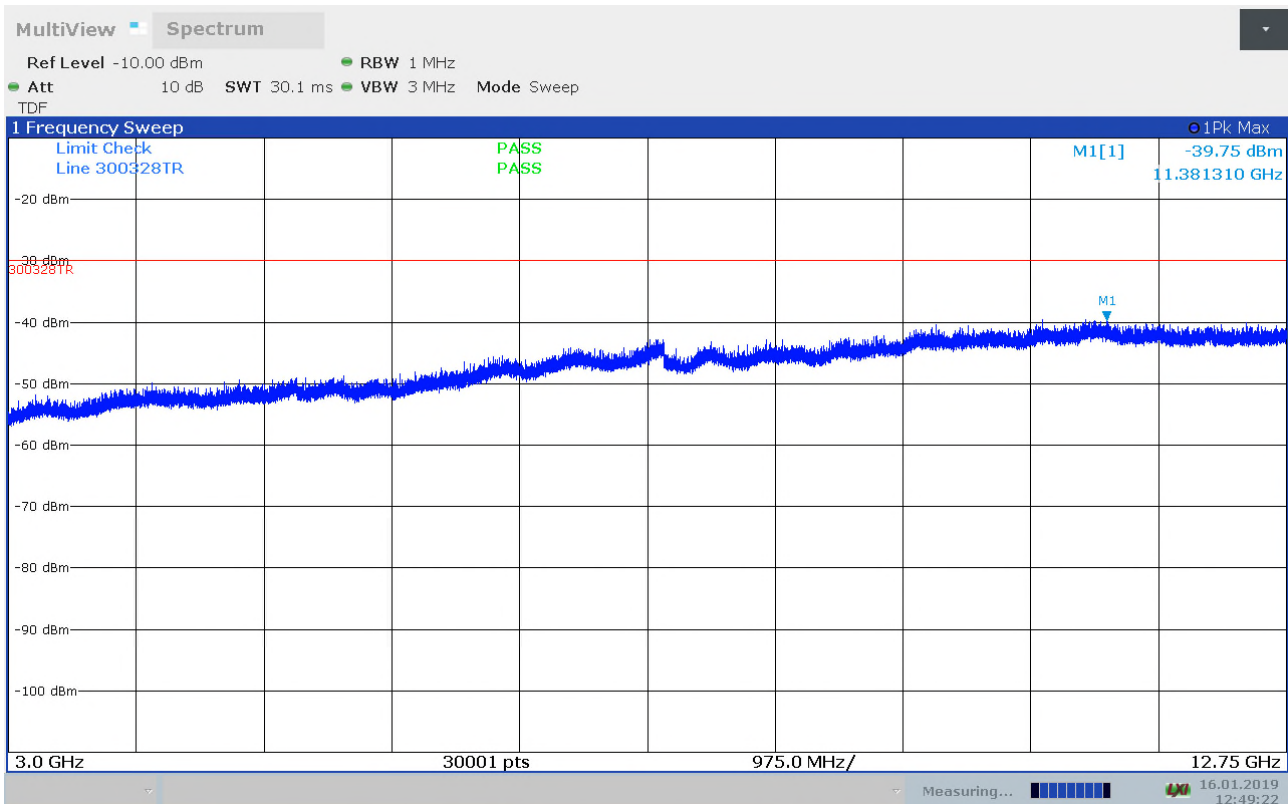
Radiated Emissions, 2.4835 - 3GHz, 2402MHz, HP



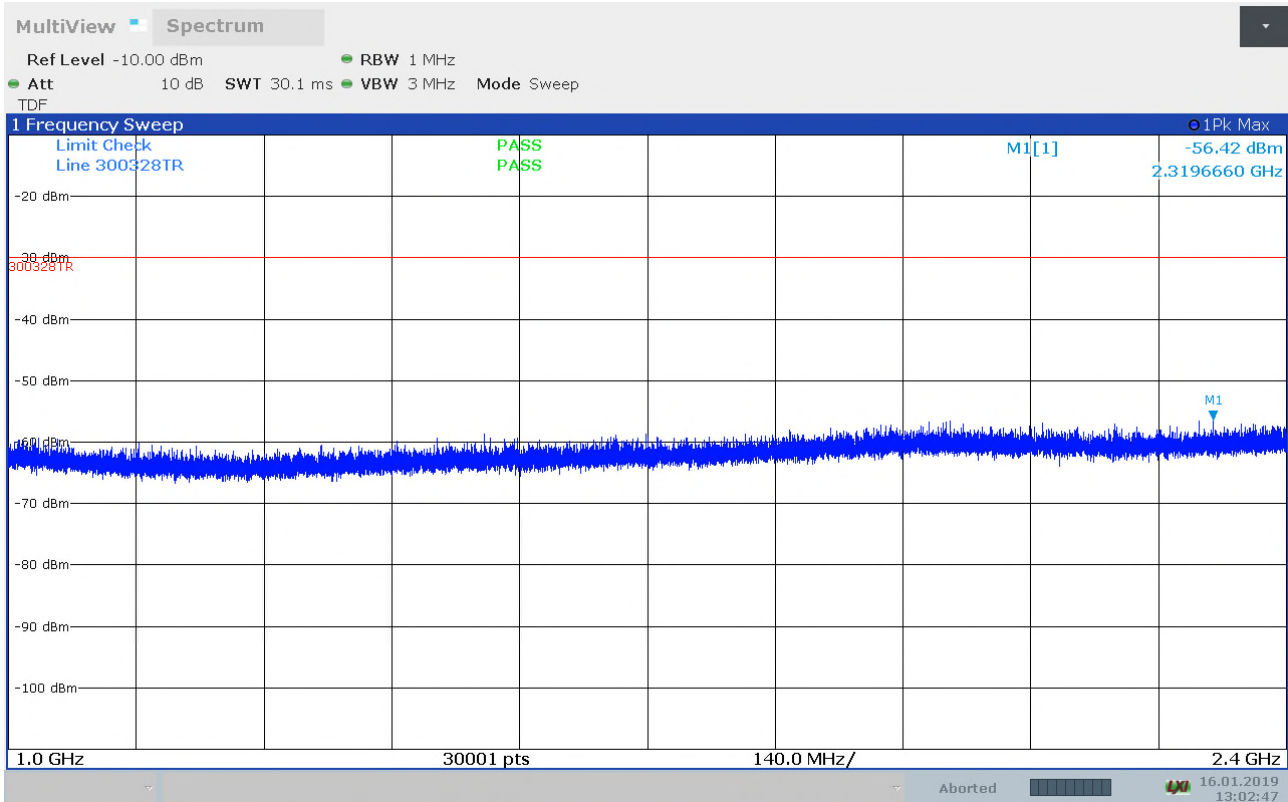
Radiated Emissions, 2.4835 - 3GHz, 2402MHz, VP



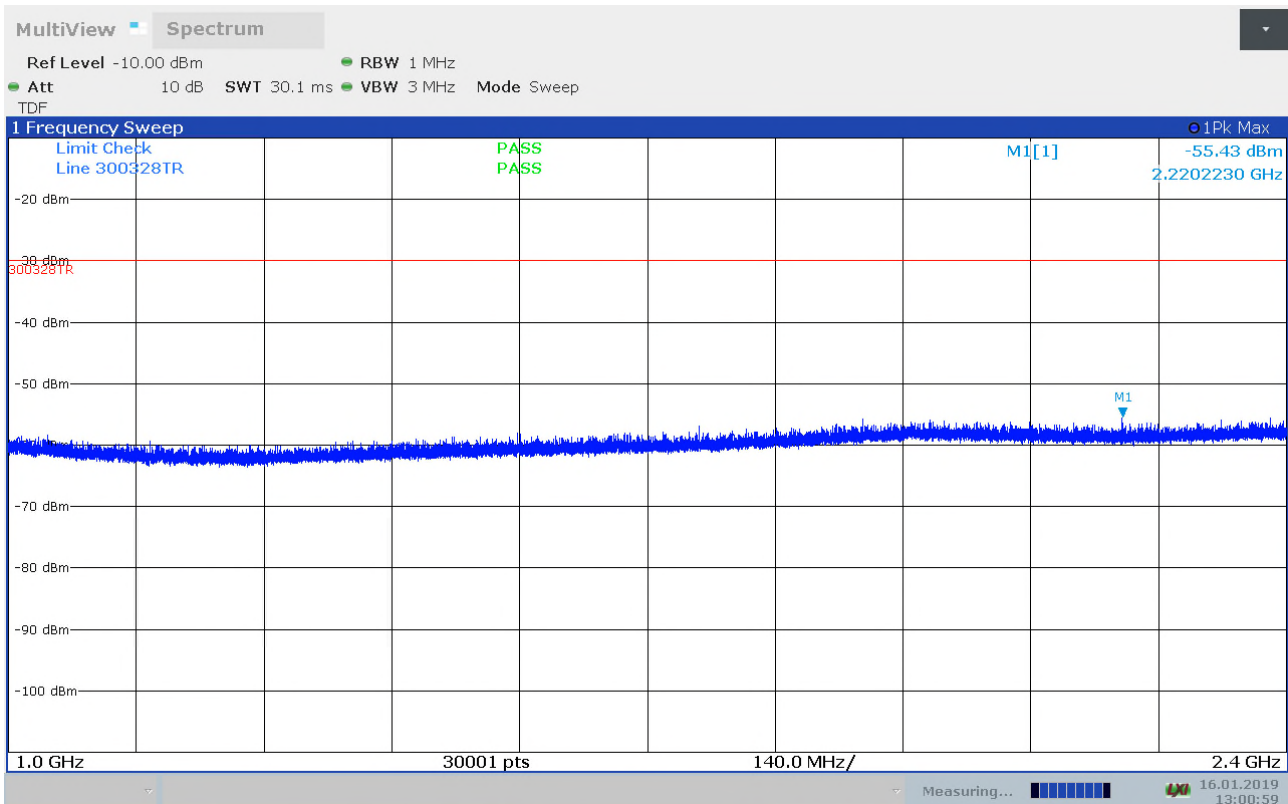
Radiated Emissions, 3 – 12.75GHz, 2402MHz, HP



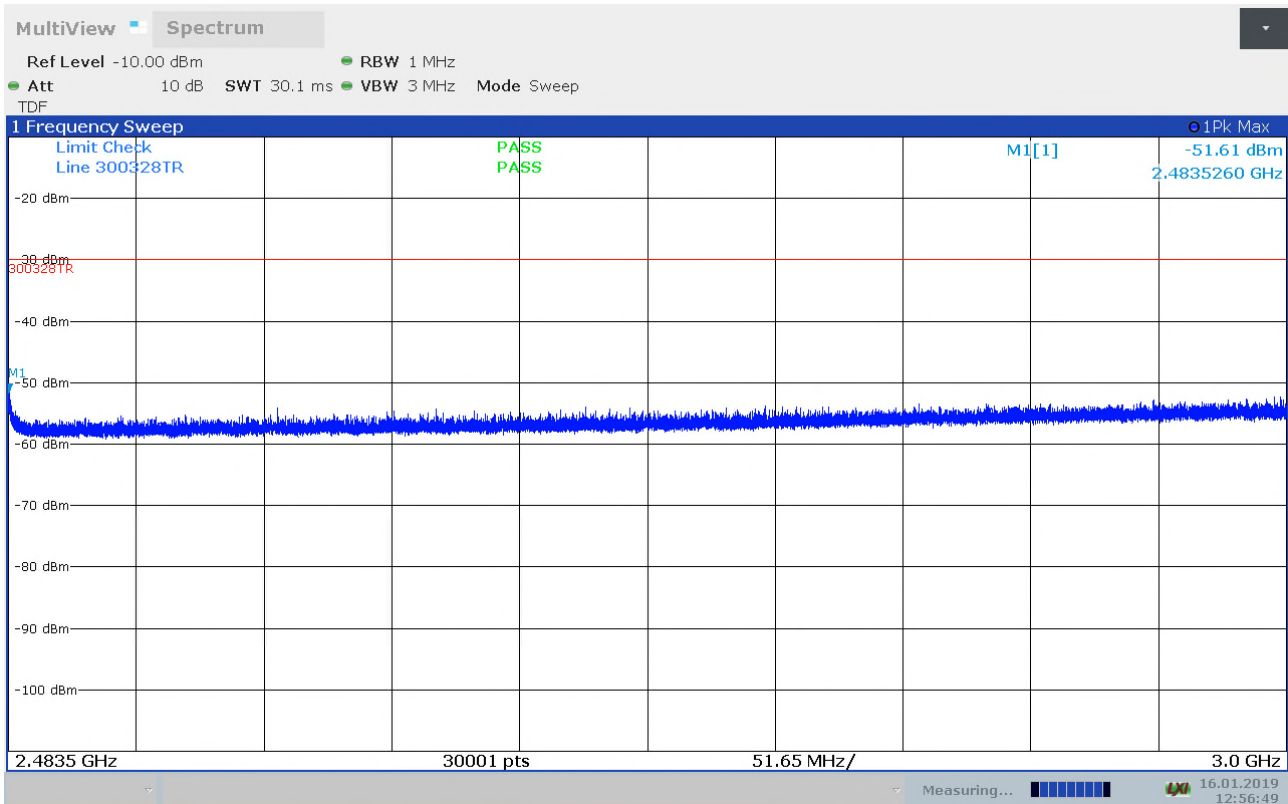
Radiated Emissions, 3 – 12.75GHz, 2402MHz, VP



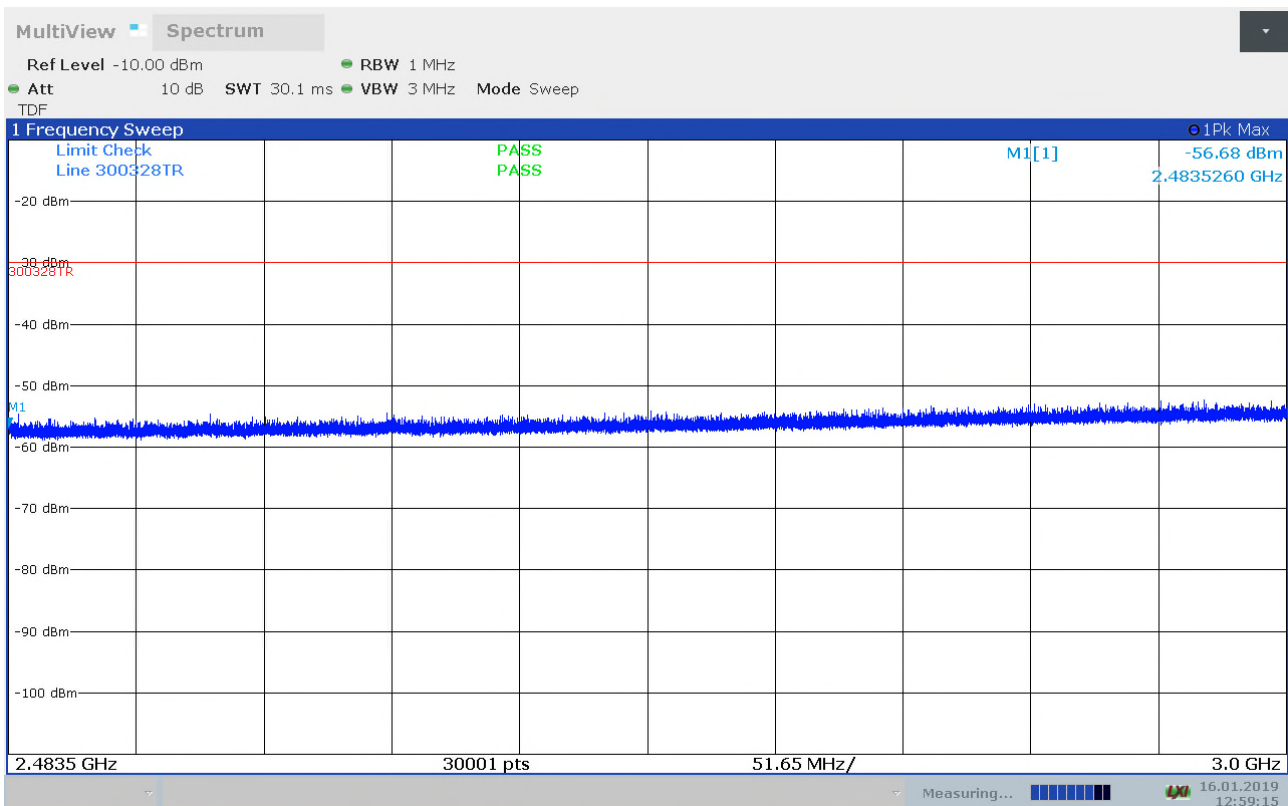
Radiated Emissions, 1 - 2.4GHz, 2480MHz, HP



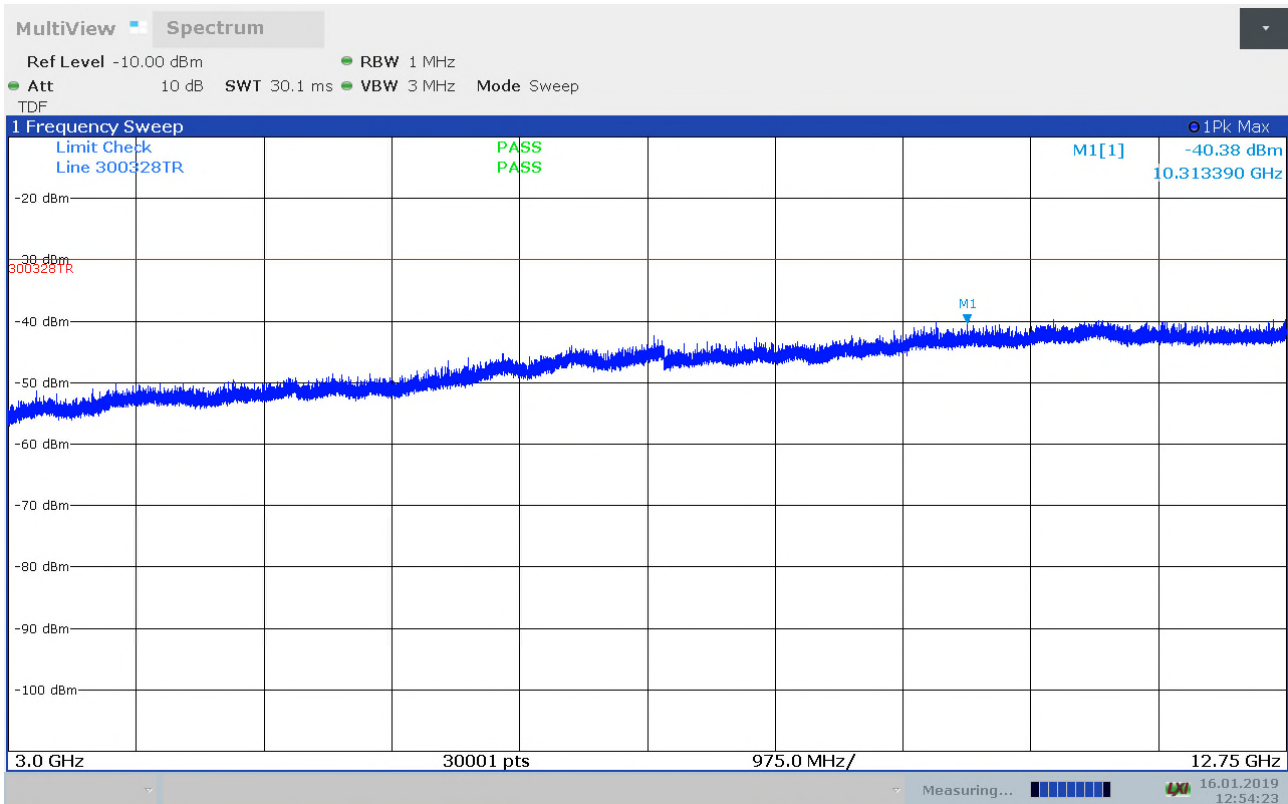
Radiated Emissions, 1 - 2.4GHz, 2480MHz, VP



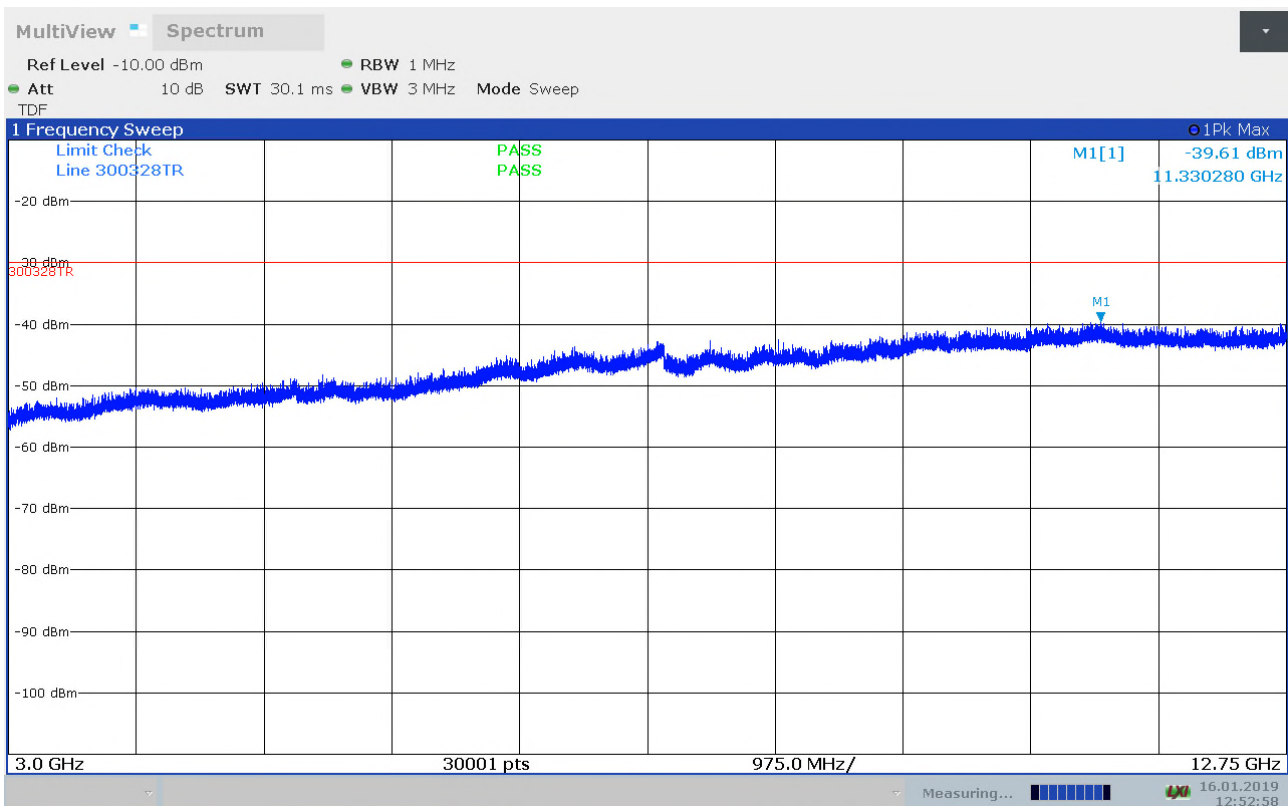
Radiated Emissions, 2.4835 - 3GHz, 2480MHz, HP



Radiated Emissions, 2.4835 - 3GHz, 2480MHz, VP



Radiated Emissions, 3 – 12.75GHz, 2480MHz, HP



Radiated Emissions, 3 – 12.75GHz, 2480MHz, VP

4.3 Transmitter spurious emissions - Radiated (Operating) - BT

ETSI EN 300 328 subclause 4.3.2.9

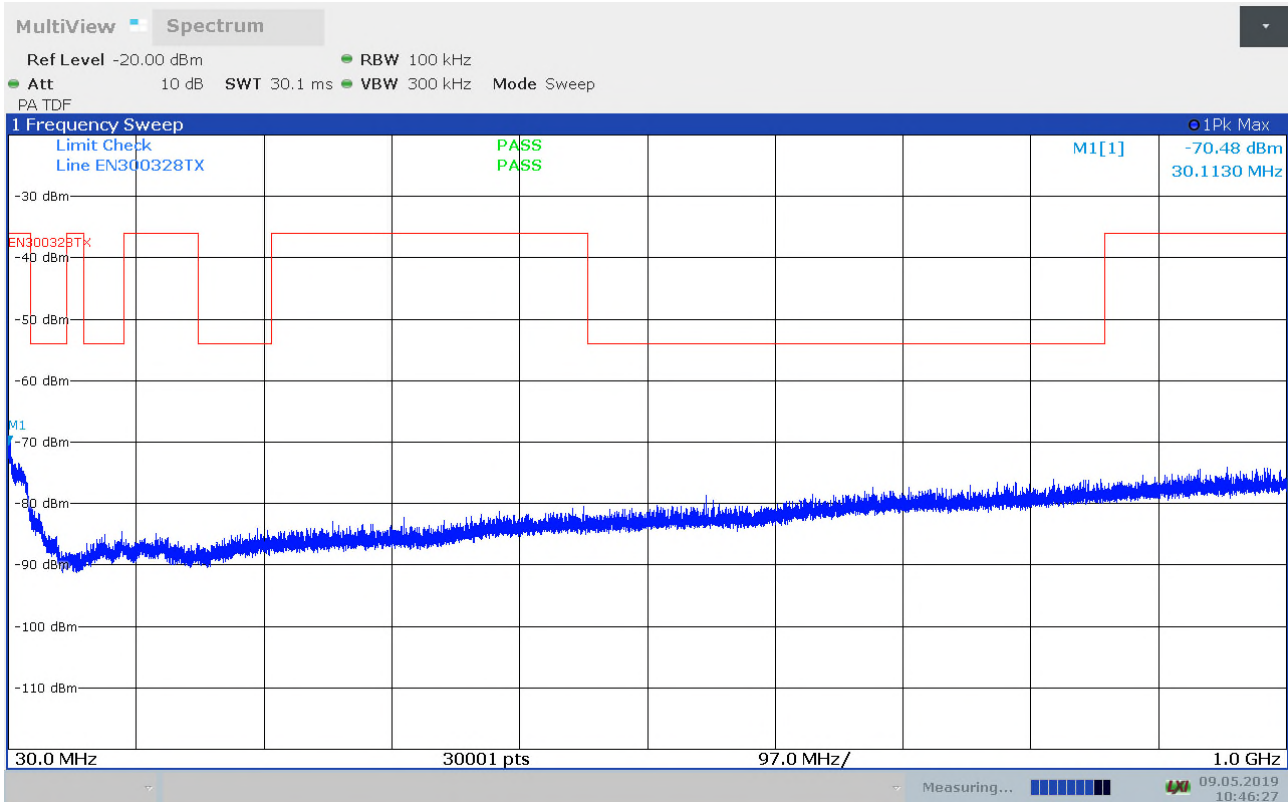
BT

Frequency (MHz)	Detector	Polarization	Spurious Emission Level (dBm)
30 – 1000 (all others)	PK	VP/HP	< -54/-36
1000 – 12750 (all others)	PK	VP/HP	< -30
Measurement uncertainty			≤ 2GHz - ± 1.1 dB 2GHz - 18 GHz - ± 2.0 dB

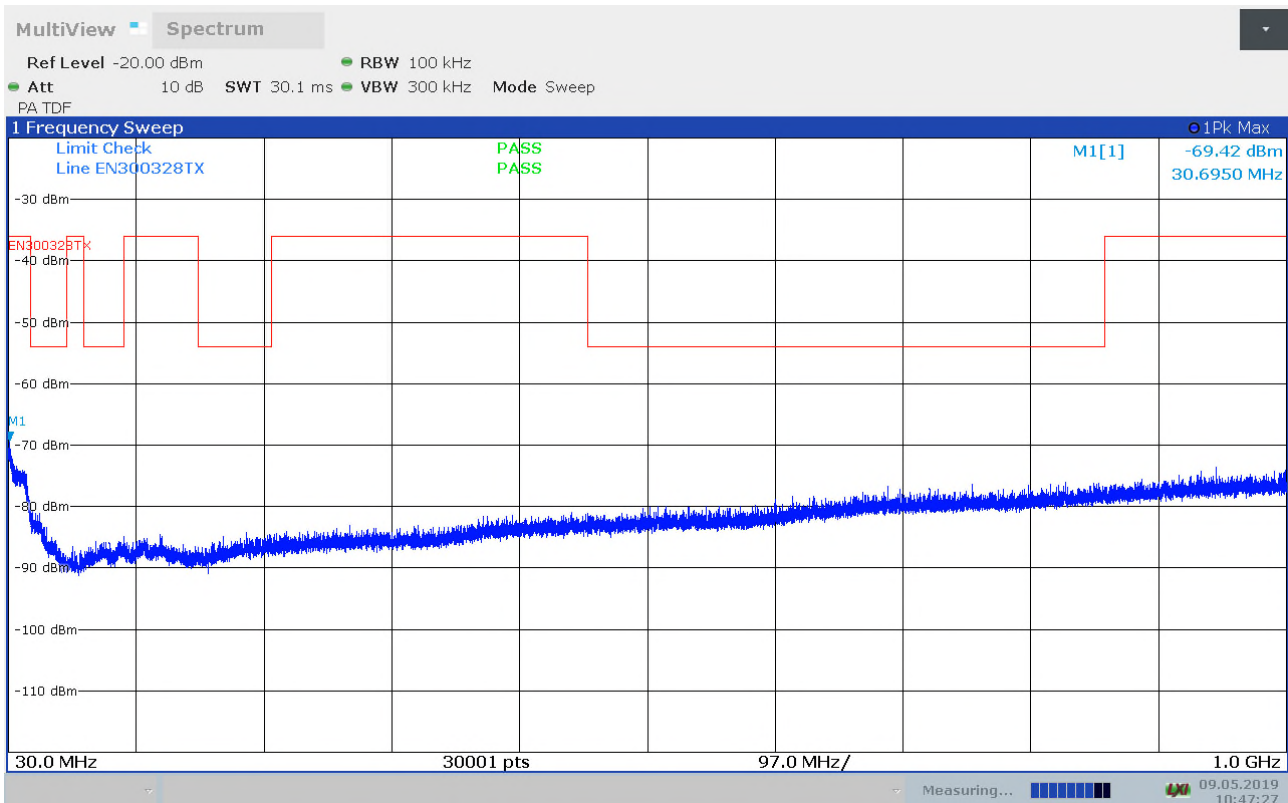
Limits: Clause 4.3.2.9.3

Frequency Range	Maximum power e.r.p. (≤ 1 GHz) e.i.r.p (> 1 GHz)	Bandwidth
30 MHz to 47 MHz	-36 dBm	100 kHz
47 MHz to 74 MHz	-54 dBm	100 kHz
74 MHz to 87.5 MHz	-36 dBm	100 kHz
87.5 MHz to 118 MHz	-54 dBm	100 kHz
118 MHz to 174 MHz	-36 dBm	100 kHz
174 MHz to 230 MHz	-54 dBm	100 kHz
230 MHz to 470 MHz	-36 dBm	100 kHz
470 MHz to 862 MHz	-54 dBm	100 kHz
862 MHz to 1 GHz	-36 dBm	100 kHz
1 GHz to 12.75 GHz	-30 dBm	1 MHz

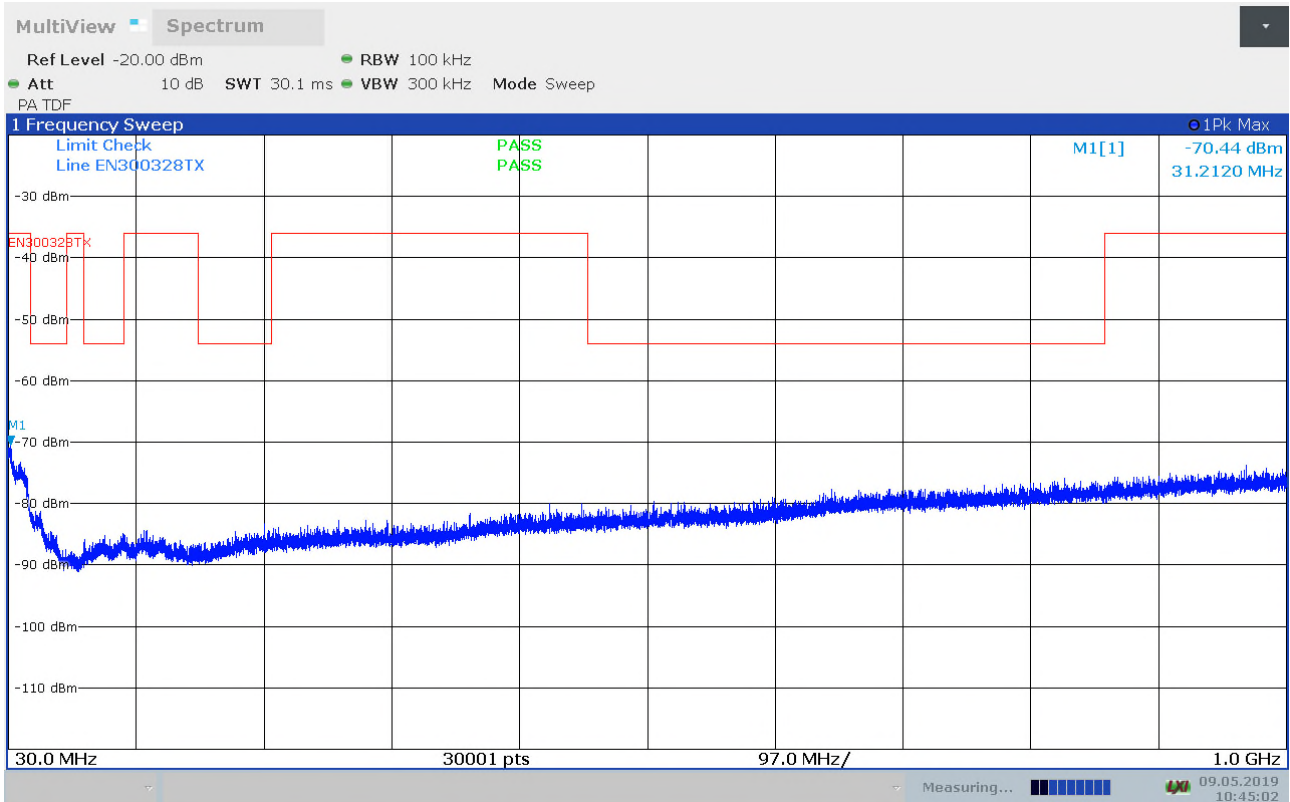
Test Equipment Used: 7,9,10,11,12,13



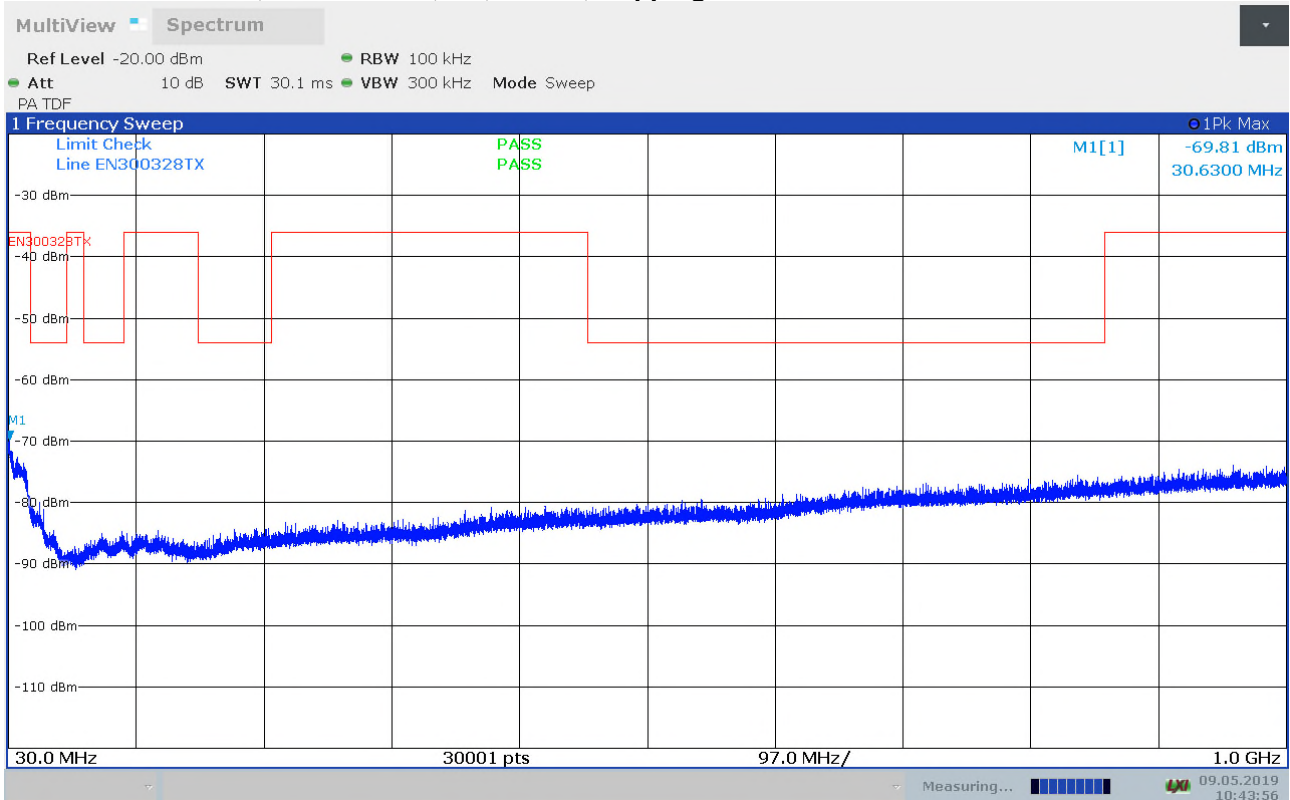
Radiated Emissions, 30 -1000MHz, HP, DH1 , Hopping mode



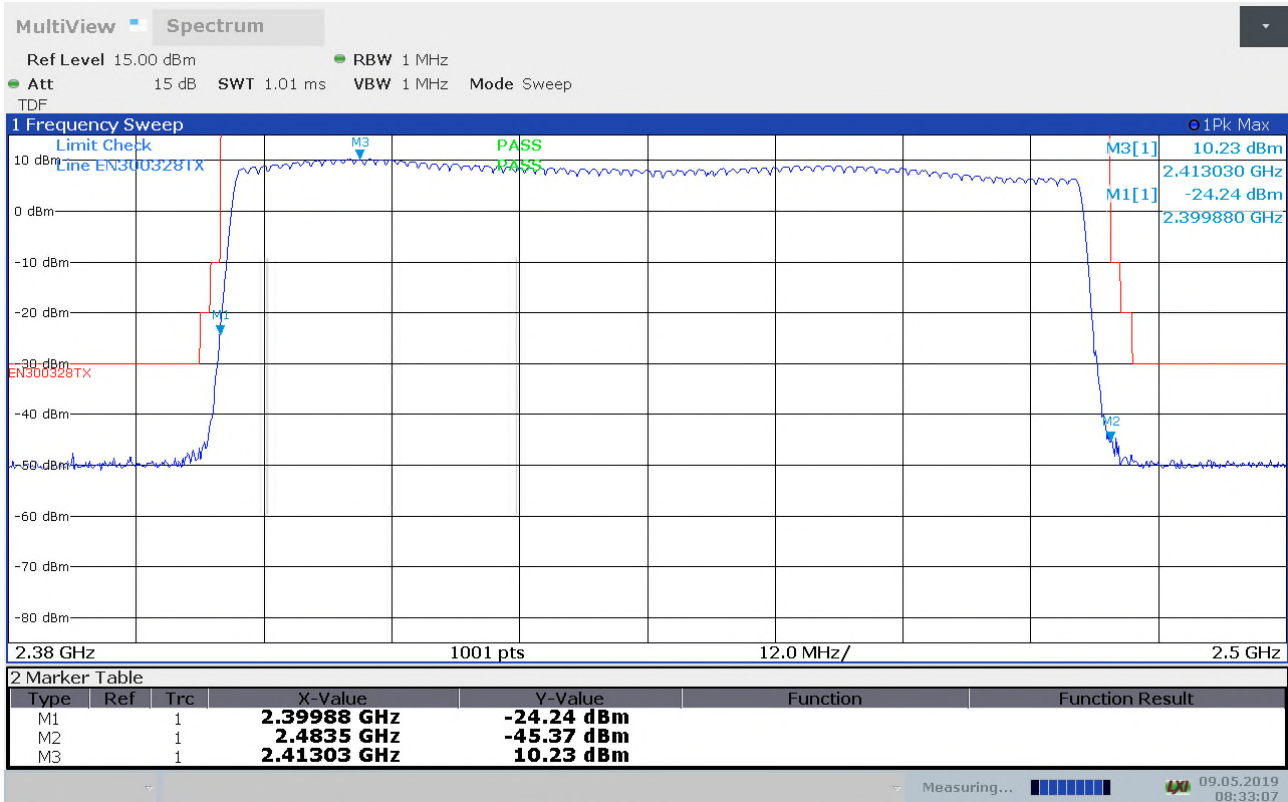
Radiated Emissions, 30 -1000MHz, VP, DH1 , Hopping mode



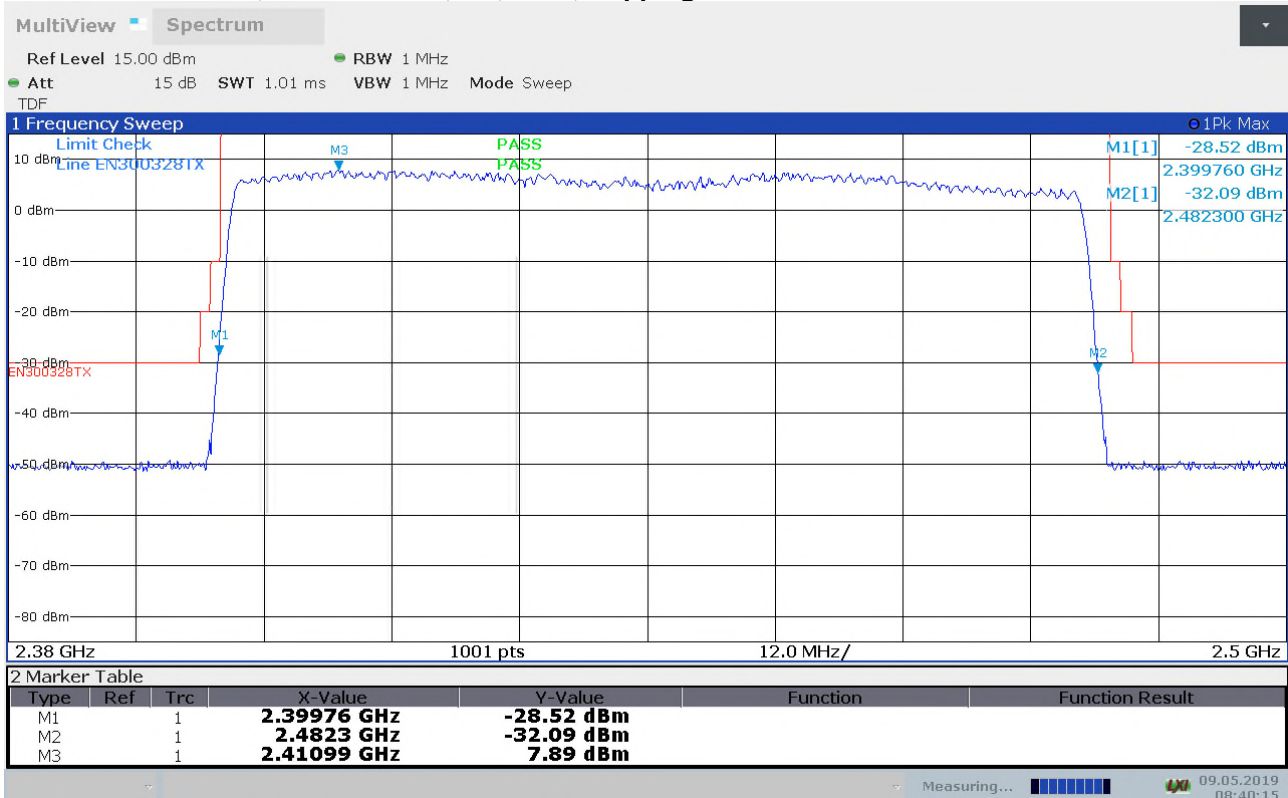
Radiated Emissions, 30 -1000MHz, HP, 3-DH1 , Hopping mode



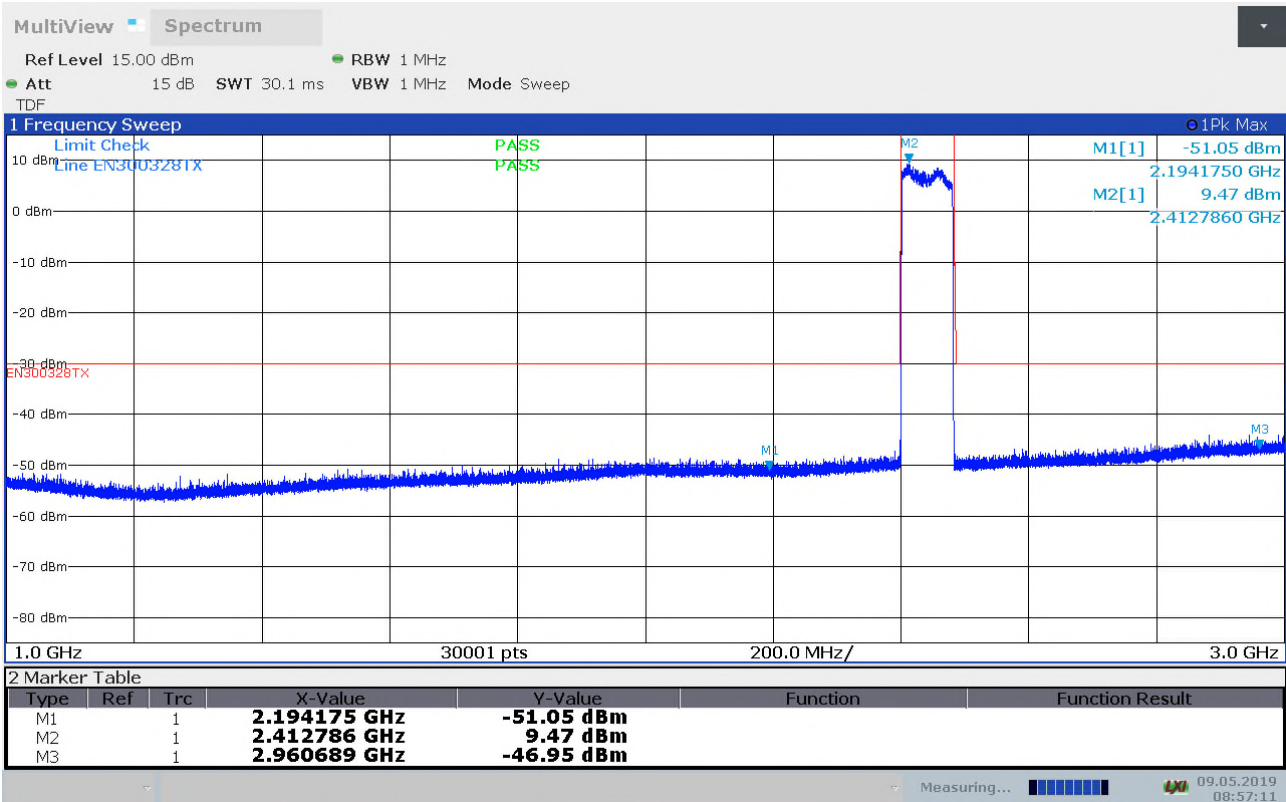
Radiated Emissions, 30 -1000MHz, VP, 3-DH1 , Hopping mode



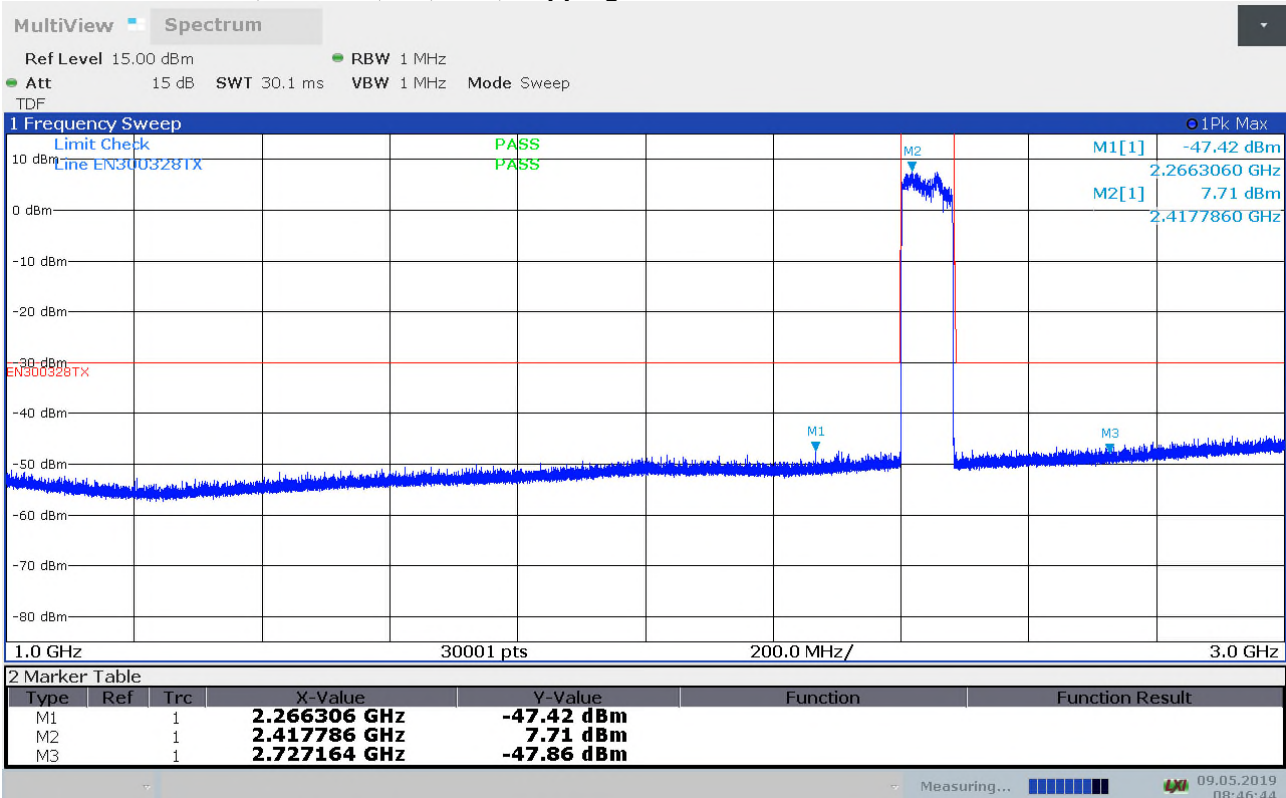
Radiated Emissions, 2.38 - 2.5GHz, HP, DH1 , Hopping mode



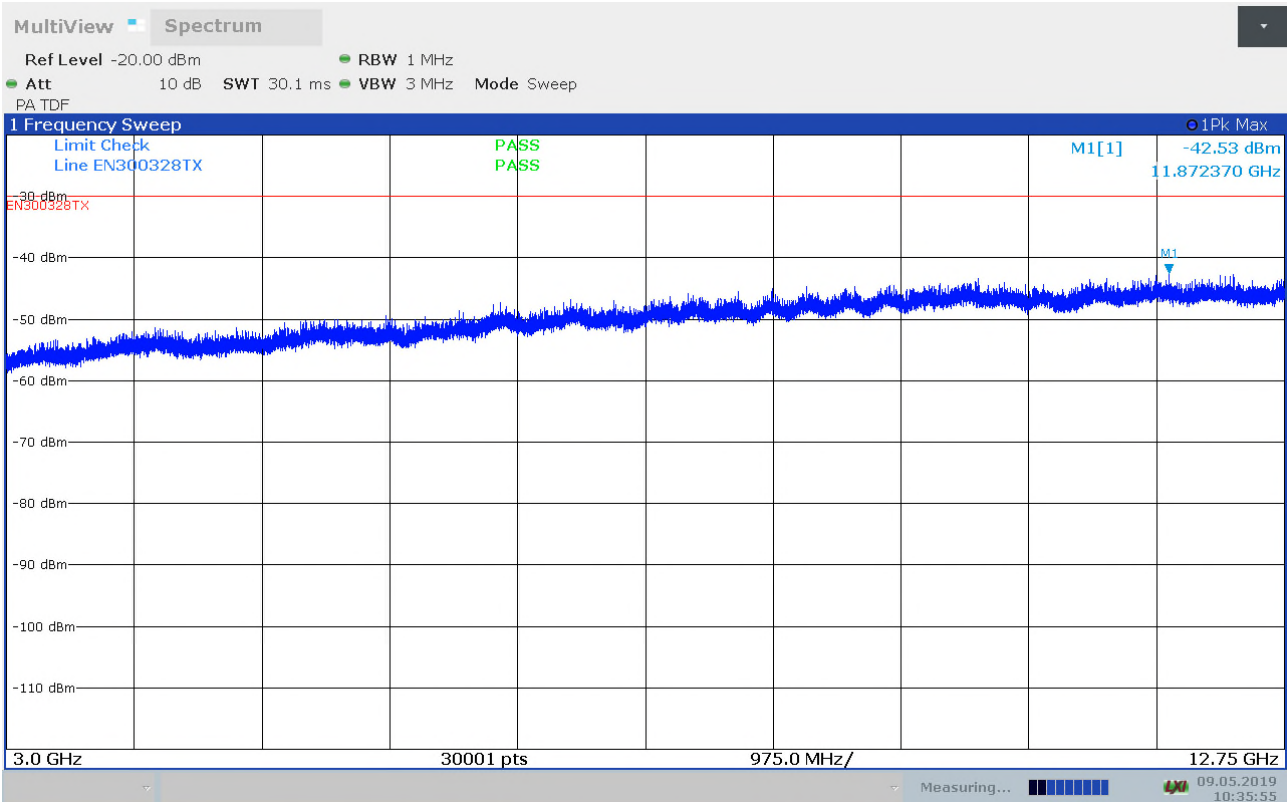
Radiated Emissions, 2.38 - 2.5GHz, HP, 3-DH1 , Hopping mode



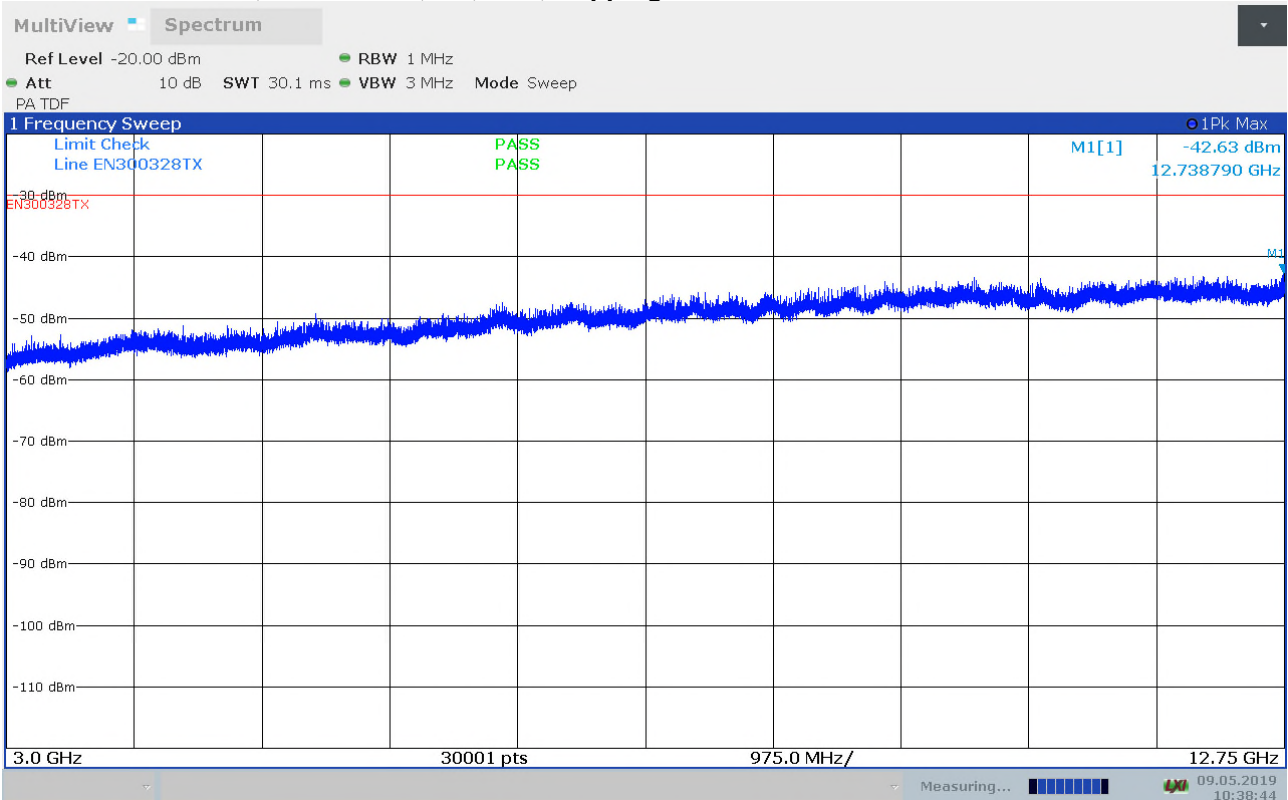
Radiated Emissions, 1 - 3GHz, HP, DH1 , Hopping mode



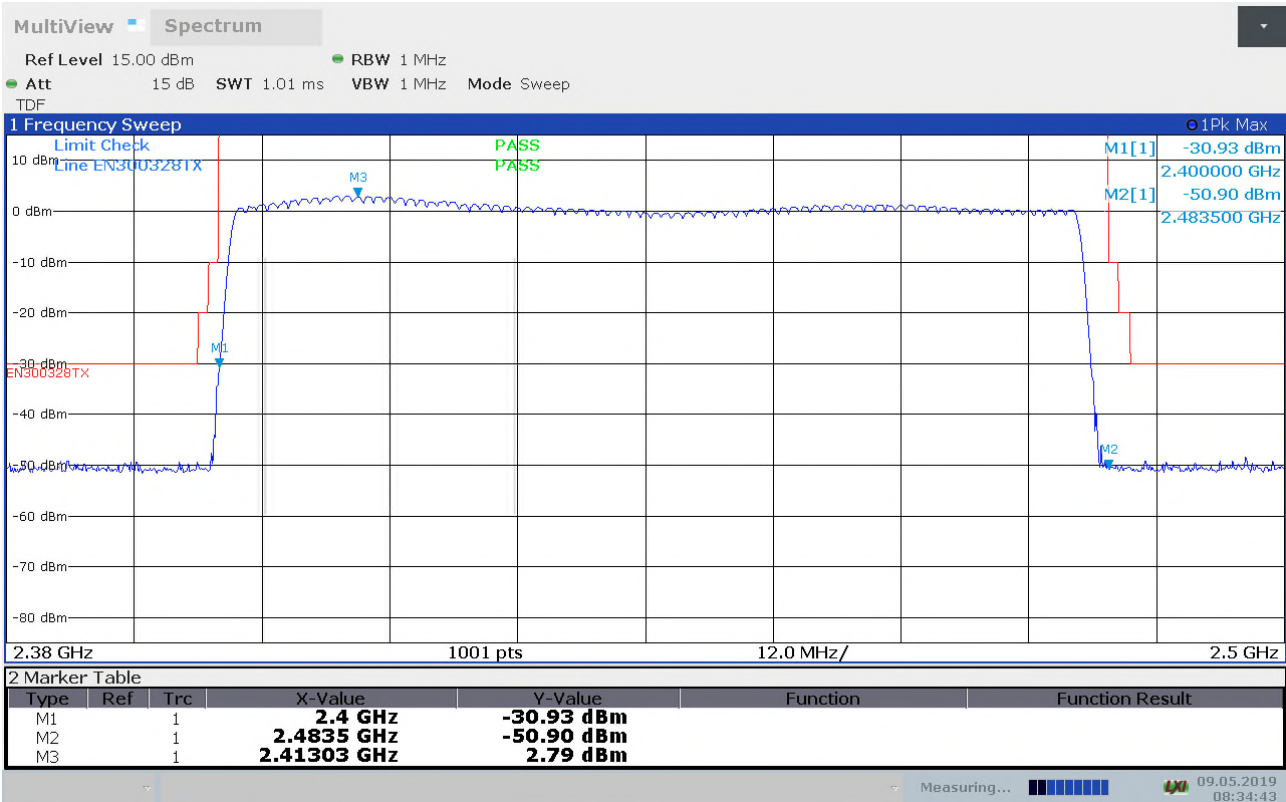
Radiated Emissions, 1 - 3GHz, HP, 3-DH1 , Hopping mode



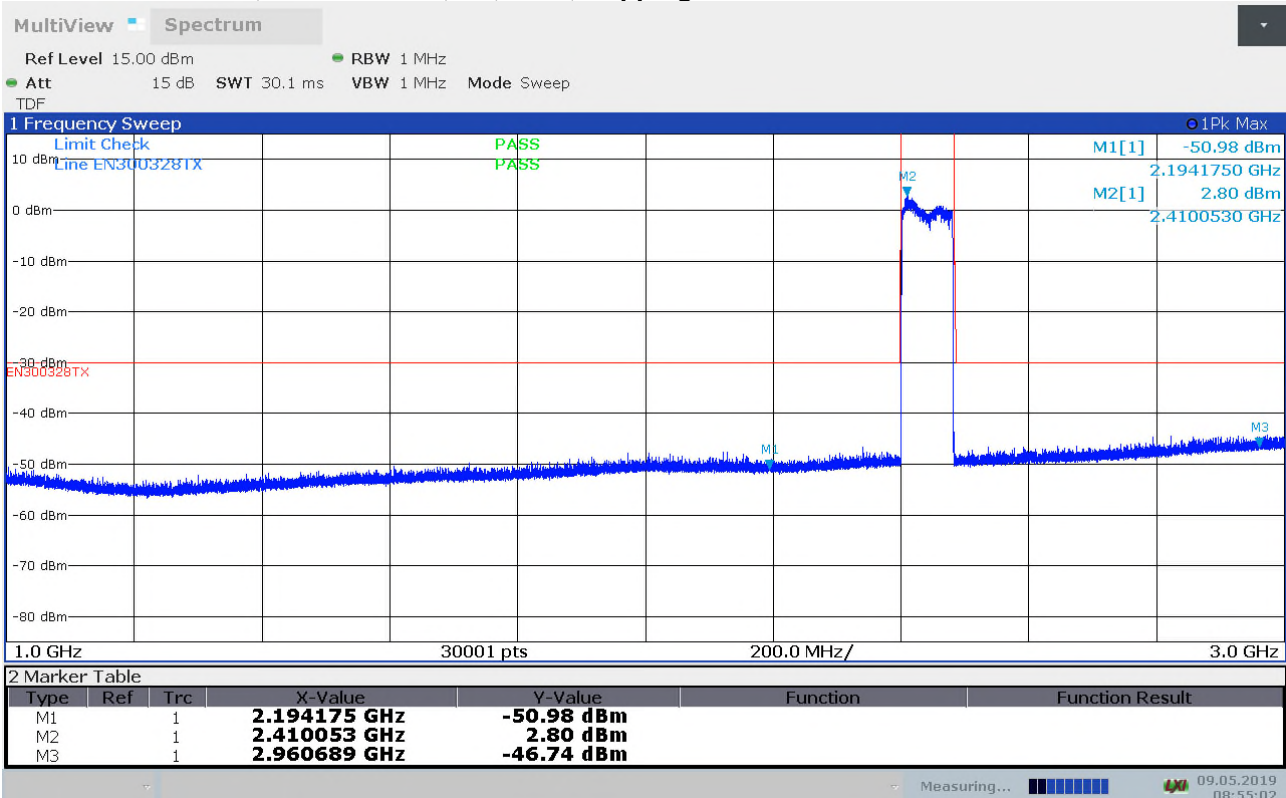
Radiated Emissions, 3 – 12.5GHz, HP,DH1 , Hopping mode



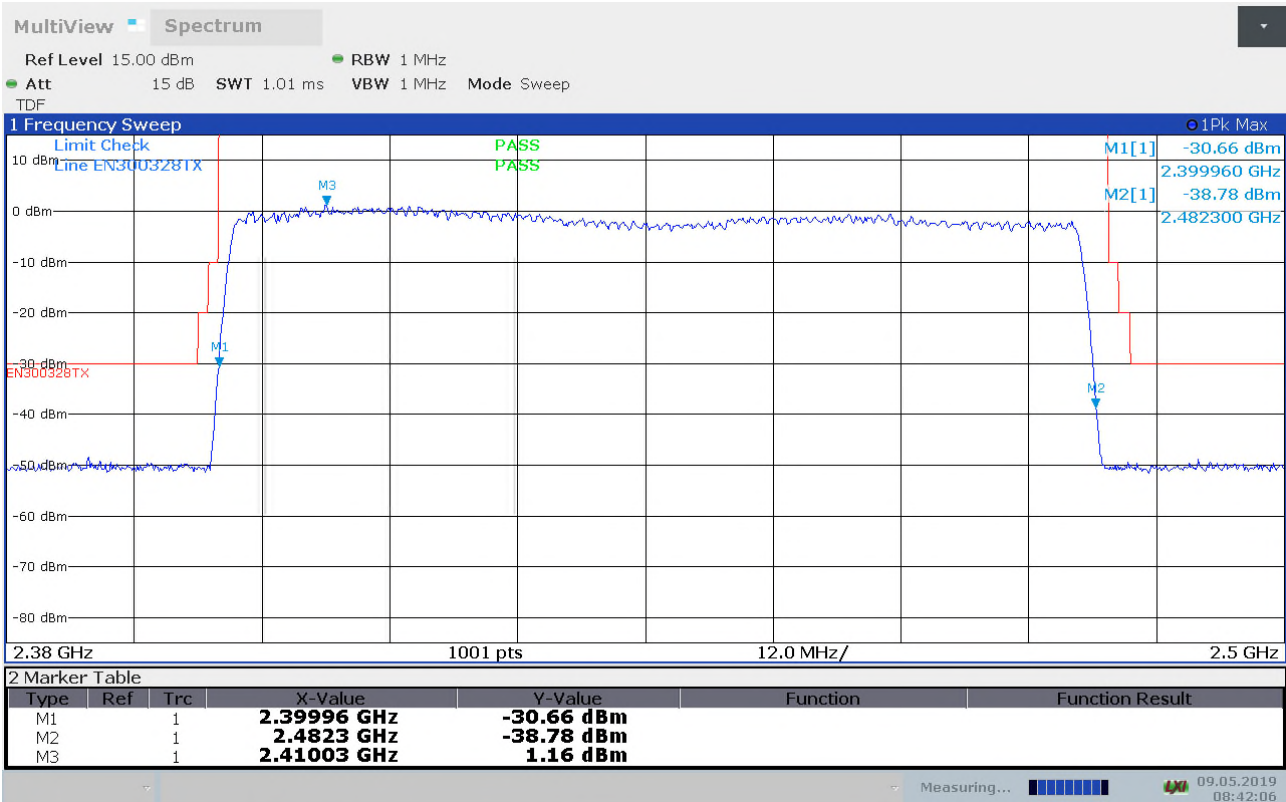
Radiated Emissions, 3 – 12.5GHz, HP, 3-DH1 , Hopping mode



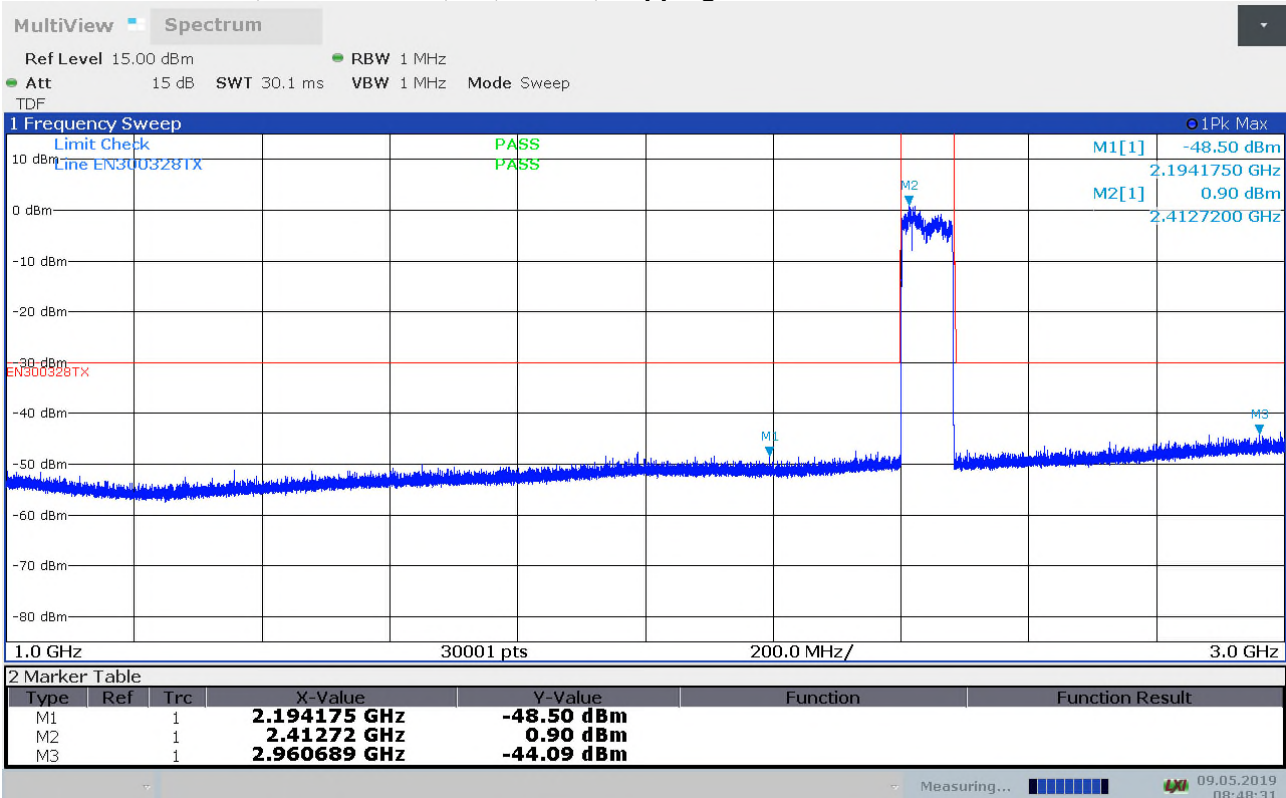
Radiated Emissions, 2.38 - 2.5GHz, VP, DH1 , Hopping mode



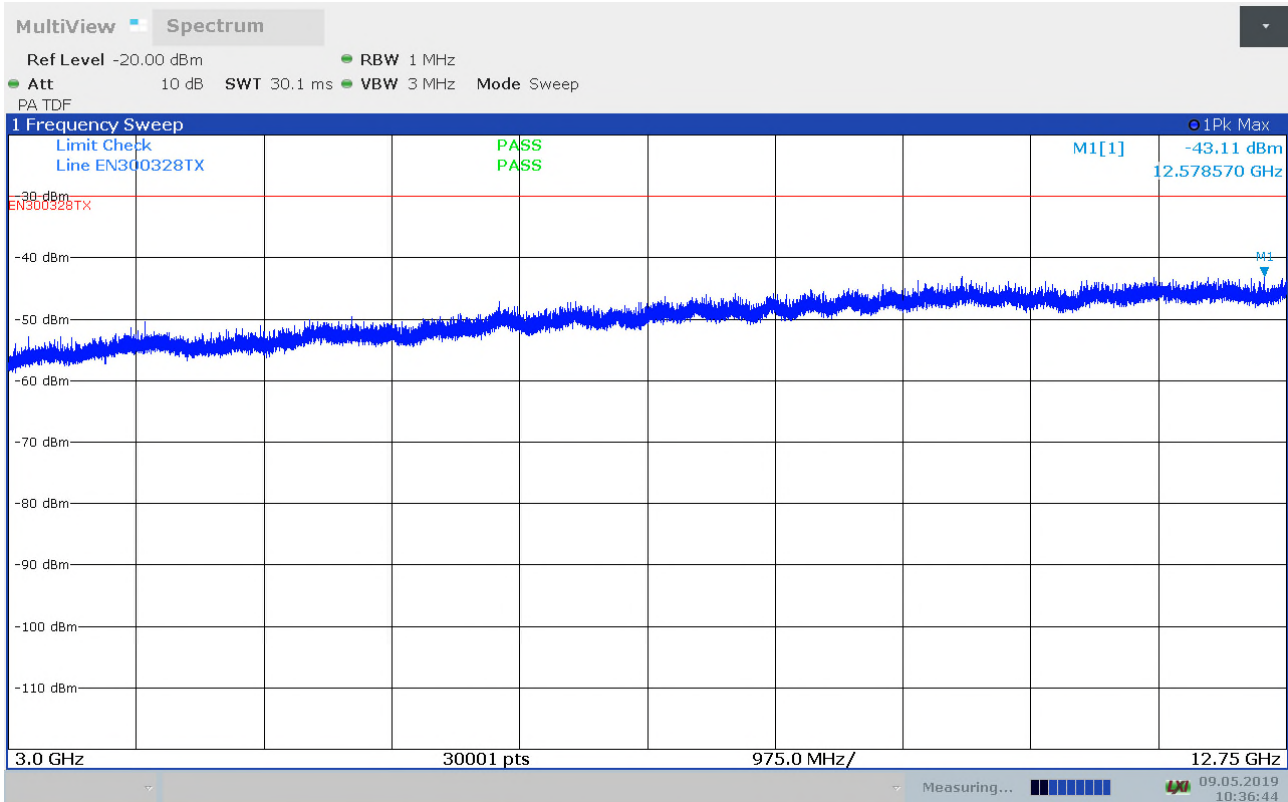
Radiated Emissions, 1 - 3GHz, VP, DH1 , Hopping mode



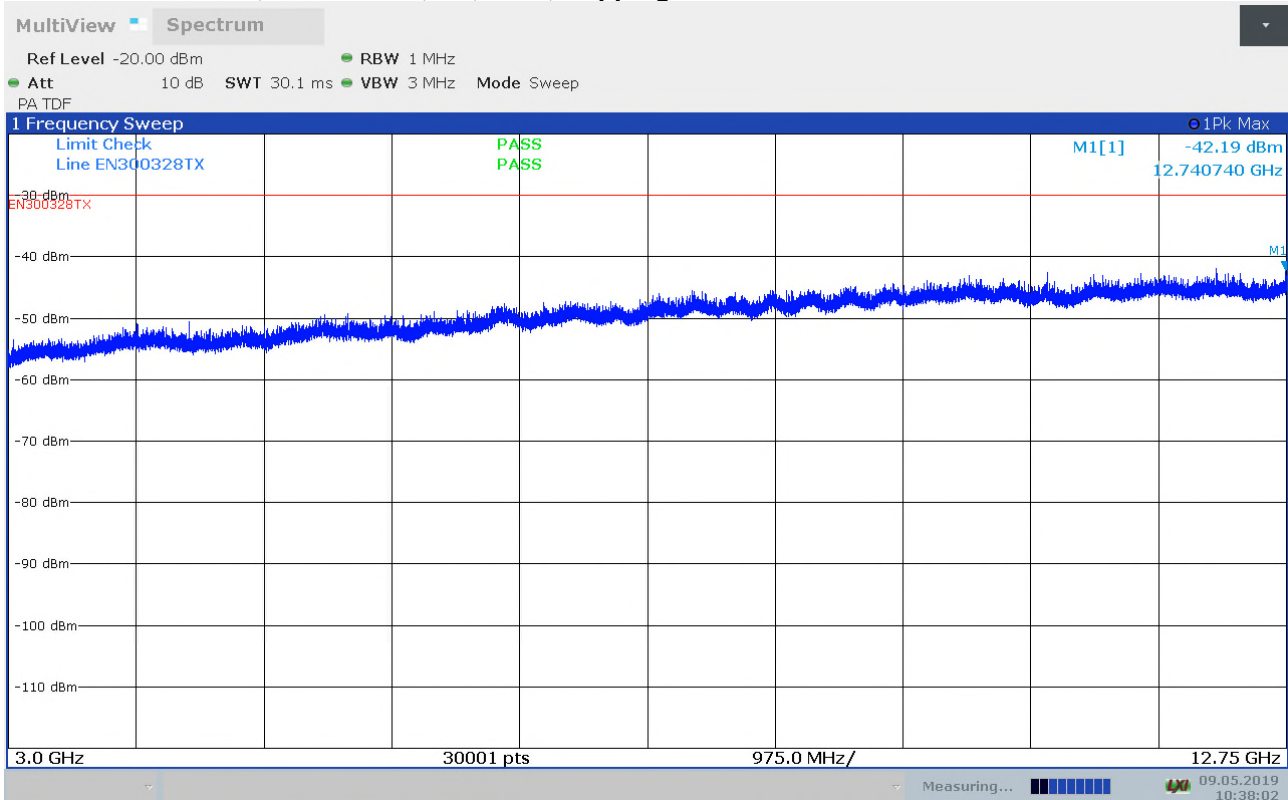
Radiated Emissions, 2.38 - 2.5GHz, VP, 3-DH1 , Hopping mode



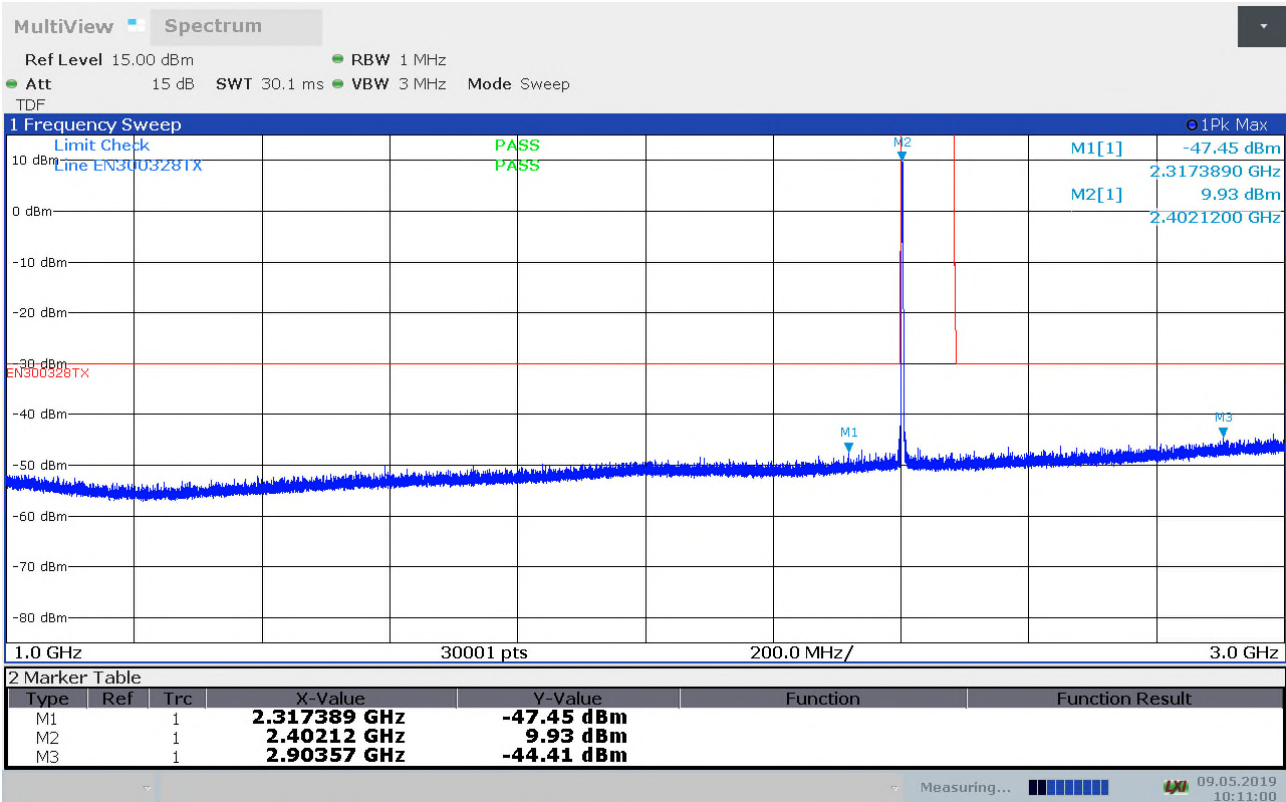
Radiated Emissions, 1 - 3GHz, VP, 3-DH1 , Hopping mode



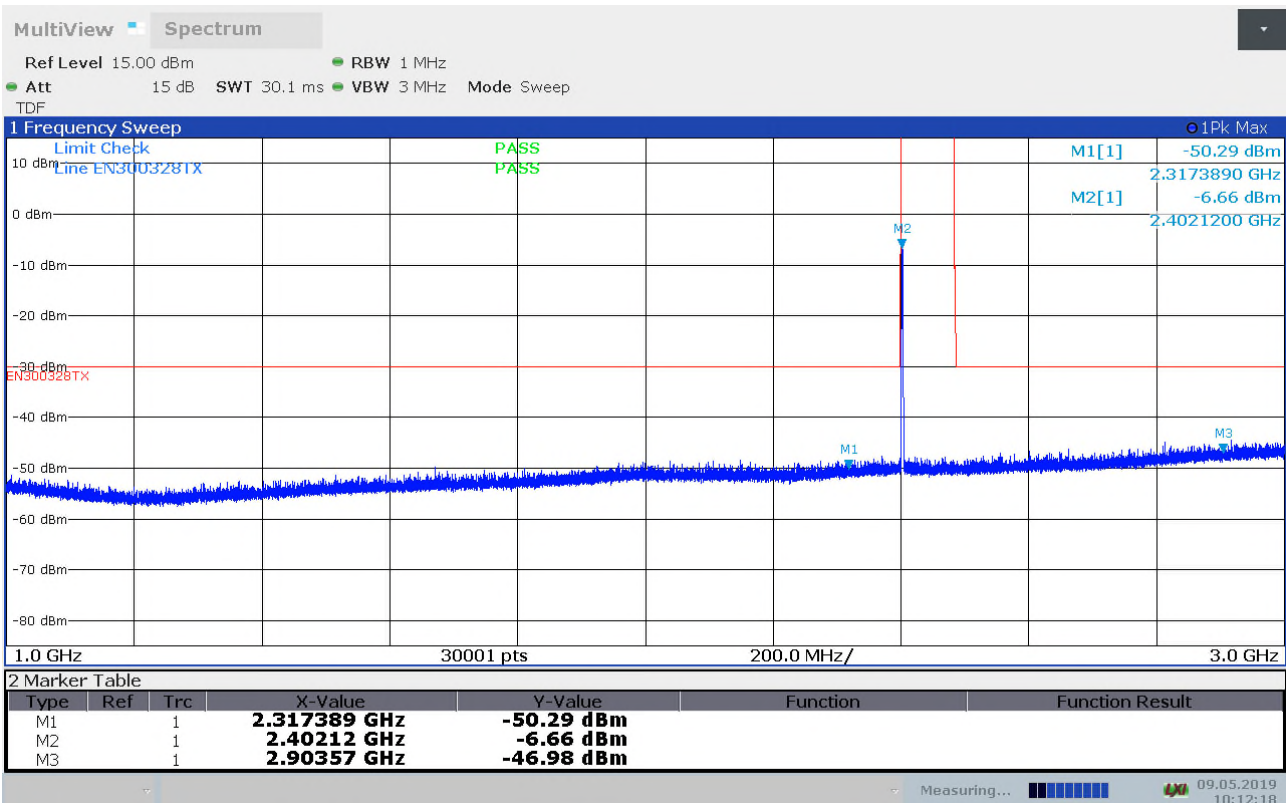
Radiated Emissions, 3 – 12.5GHz, VP, DH1 , Hopping mode



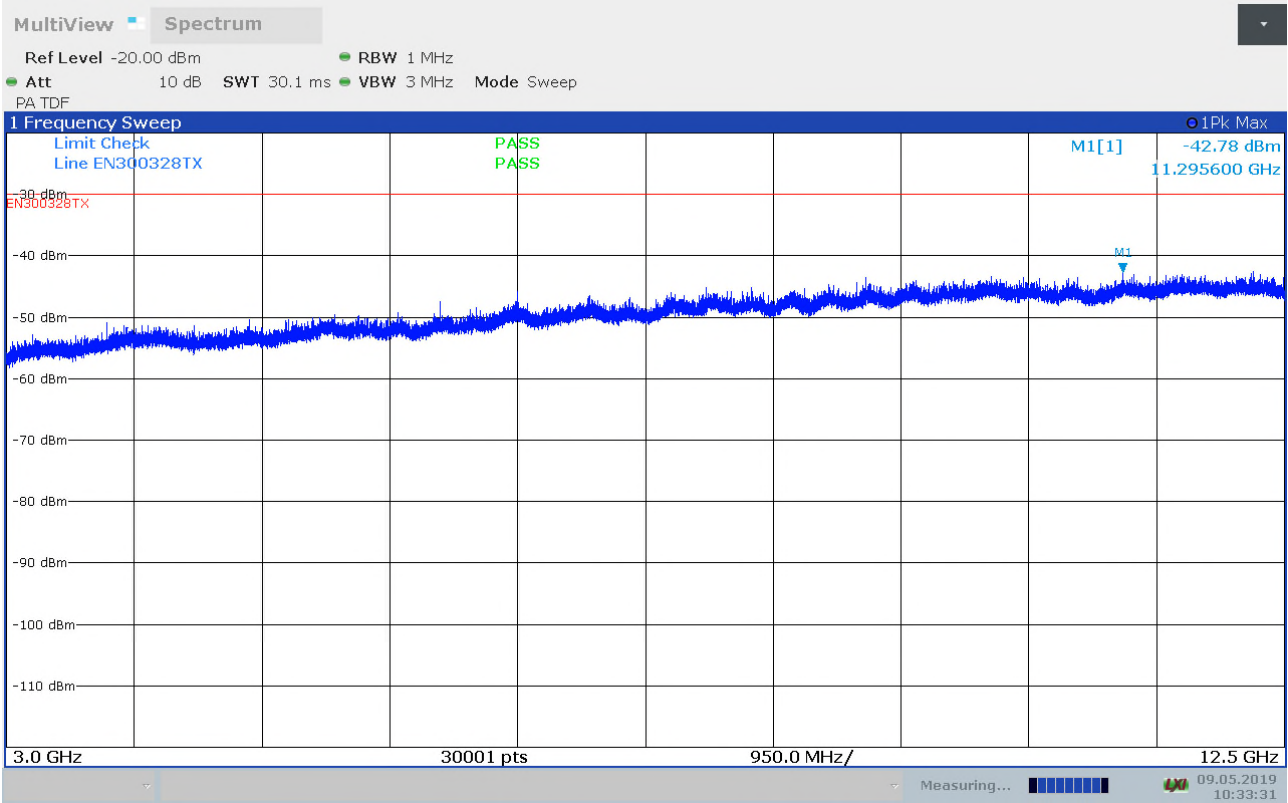
Radiated Emissions, 3 – 12.5GHz, VP, 3-DH1 , Hopping mode



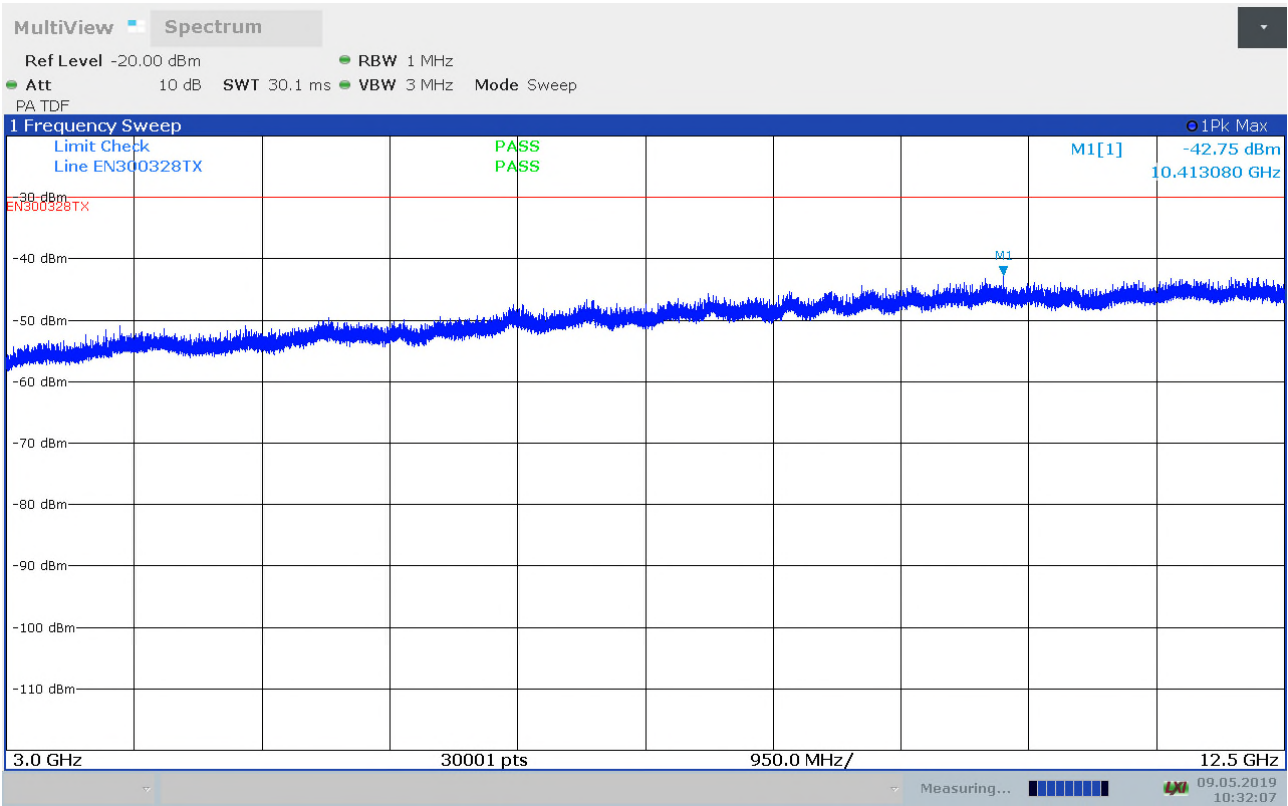
Radiated Emissions, 1 - 3GHz, 2402MHz, HP, DH1



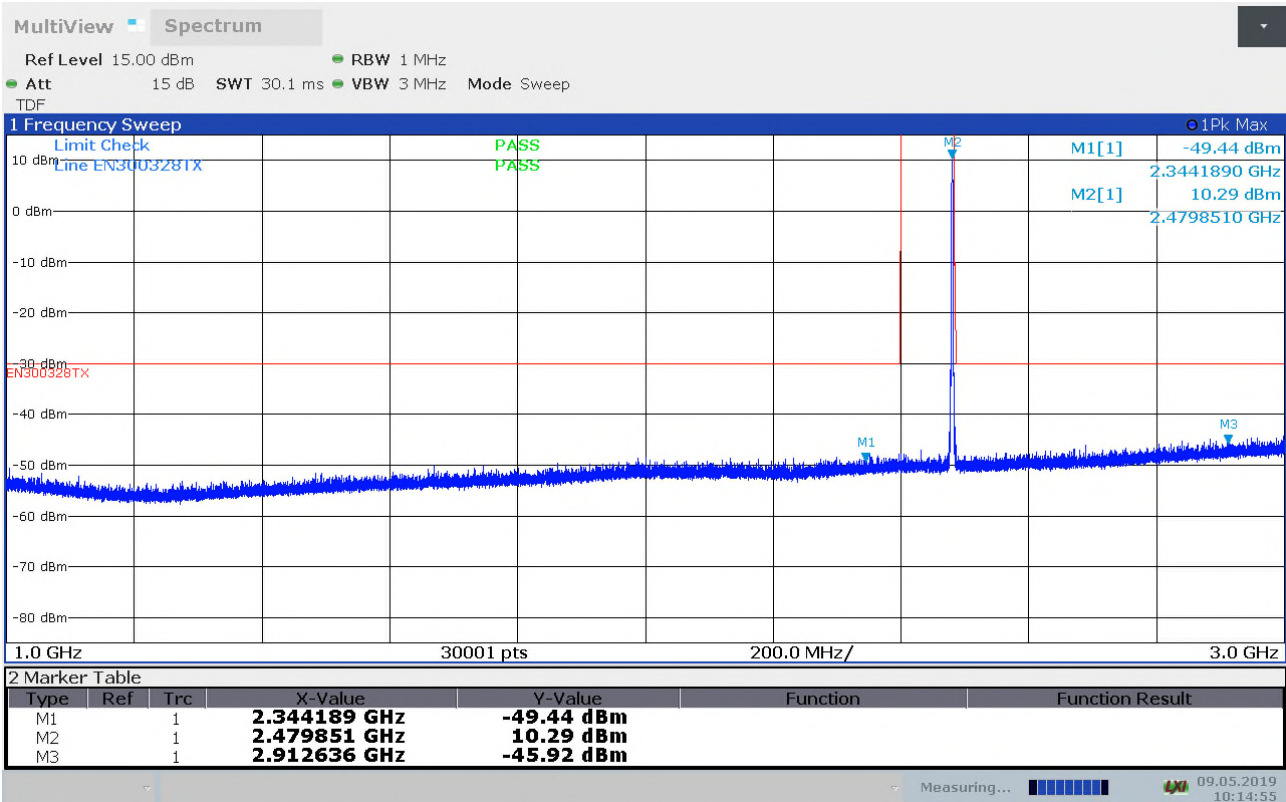
Radiated Emissions, 1 - 3GHz, 2402MHz, VP, DH1



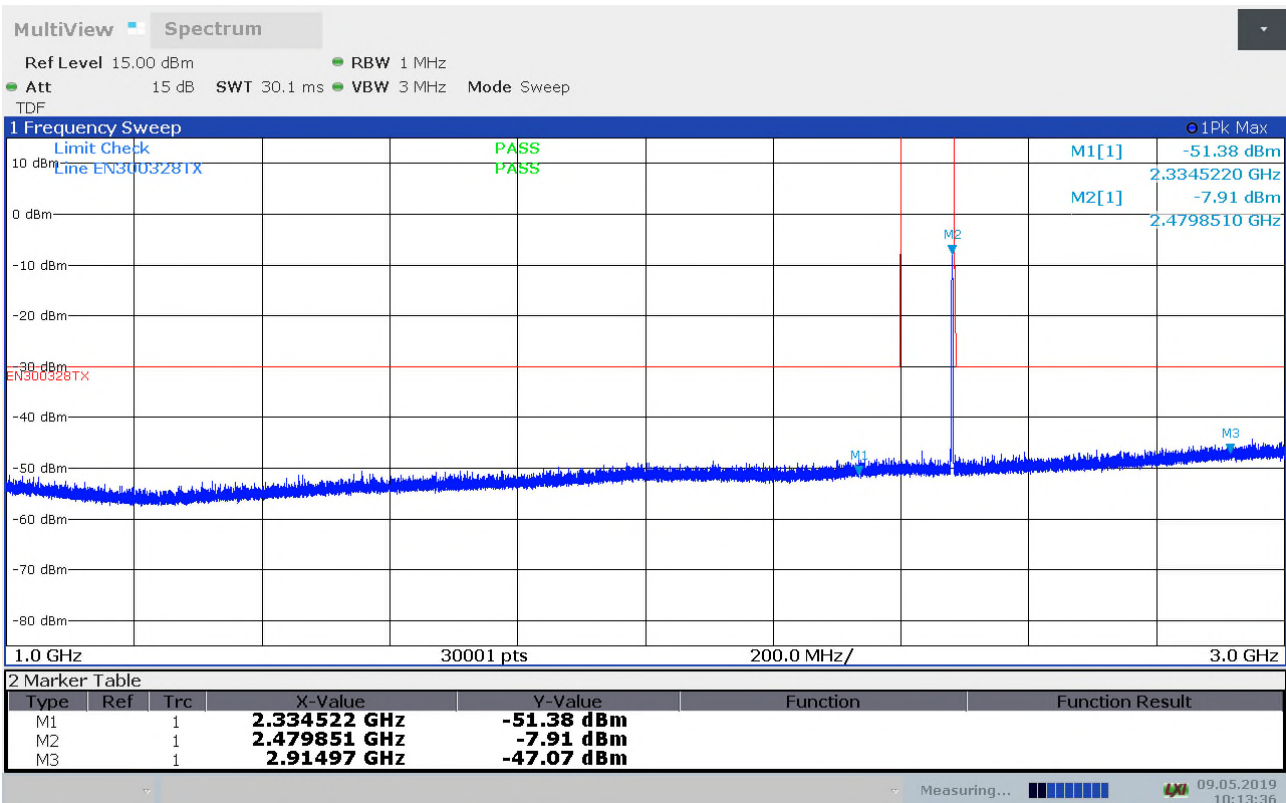
Radiated Emissions, 3 – 12.75GHz, 2402MHz, HP, DH1



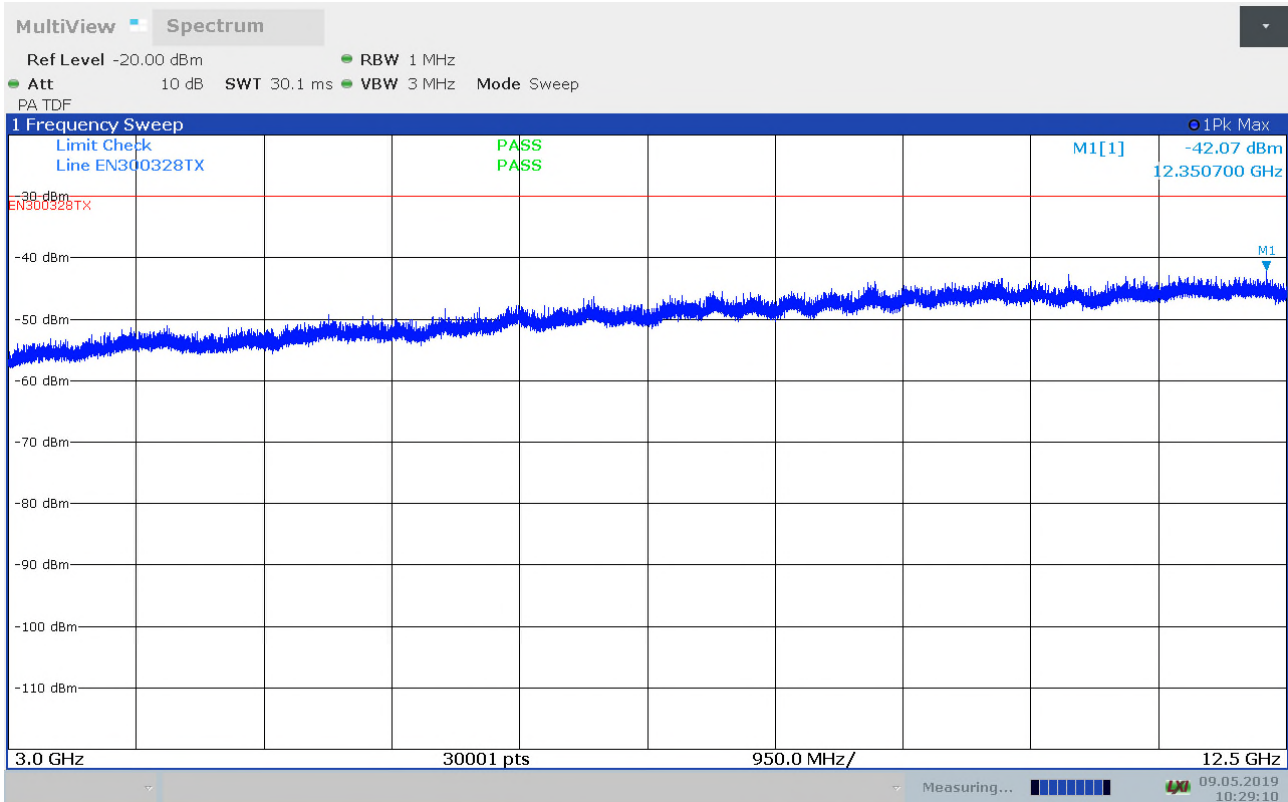
Radiated Emissions, 3 – 12.75GHz, 2402MHz, VP, DH1



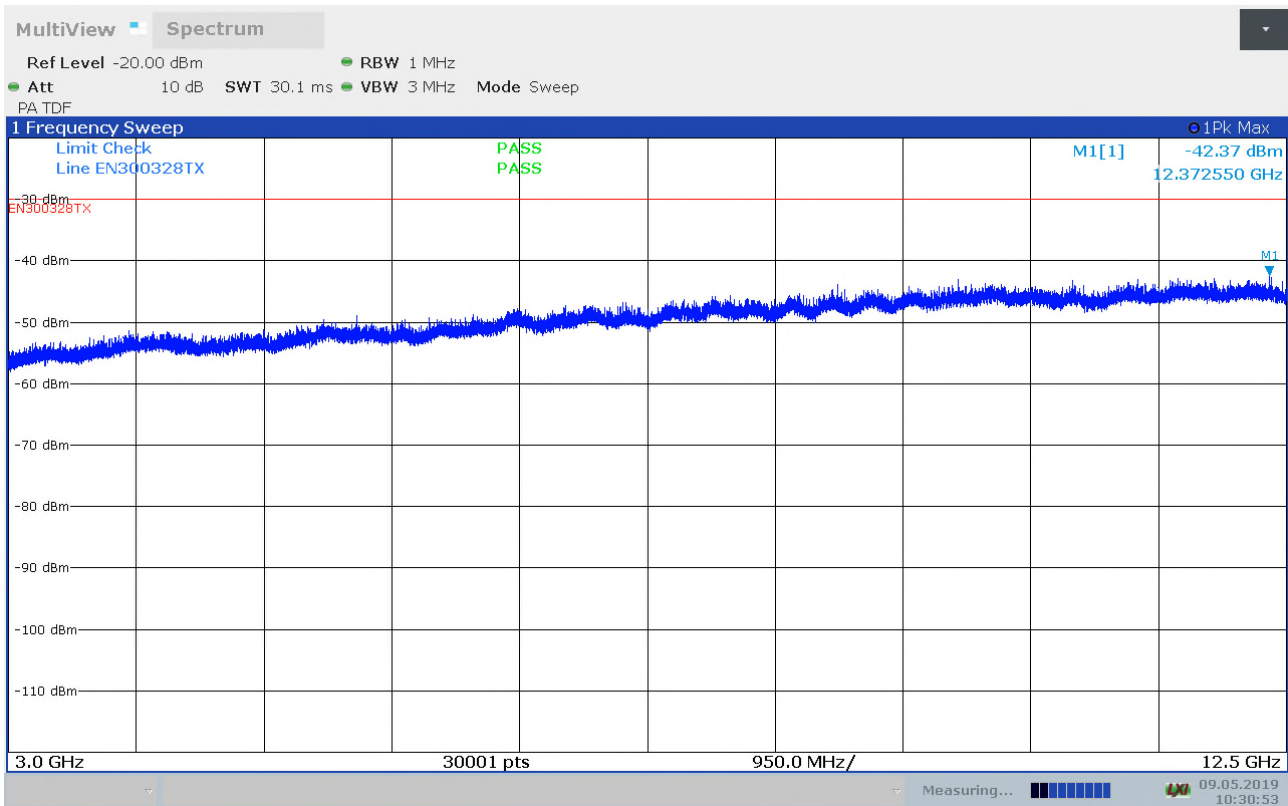
Radiated Emissions, 1 - 3GHz, 2480MHz, HP, DH1



Radiated Emissions, 1 - 3GHz, 2480MHz, VP, DH1



Radiated Emissions, 3 – 12.75GHz, 2480MHz, HP, DH1



Radiated Emissions, 3 – 12.75GHz, 2480MHz, VP, DH1

4.4 Receiver spurious emissions – Radiated - BLE/BT

ETSI EN 300 328 subclause 4.3.2.10

BLE/BT

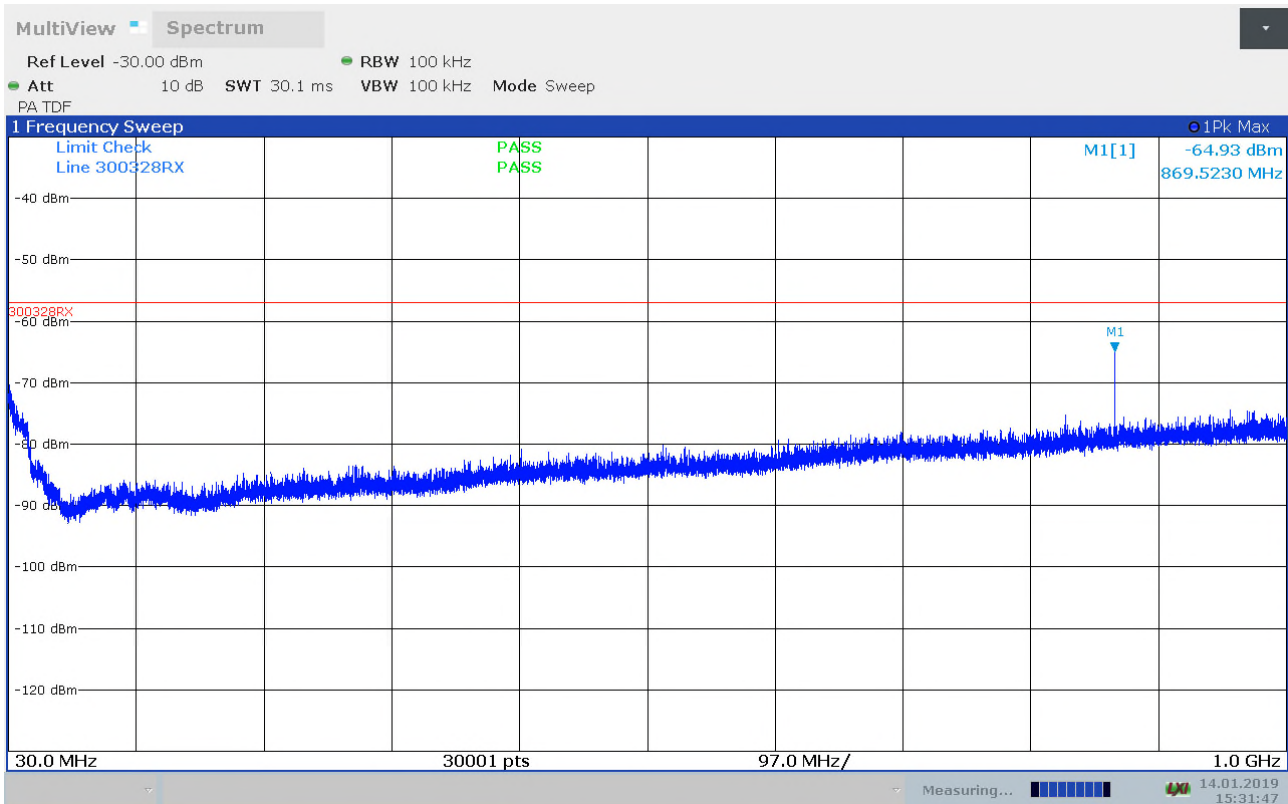
Frequency (MHz)	Detector	Polarization	Spurious Emission Level (dBm)
30 – 1000 (all others)	PK	VP/HP	<-57
1000 – 12750 (all others)	PK	VP/HP	< -47

The RBW of 100 kHz is used above 5GHz, because of large background noise.

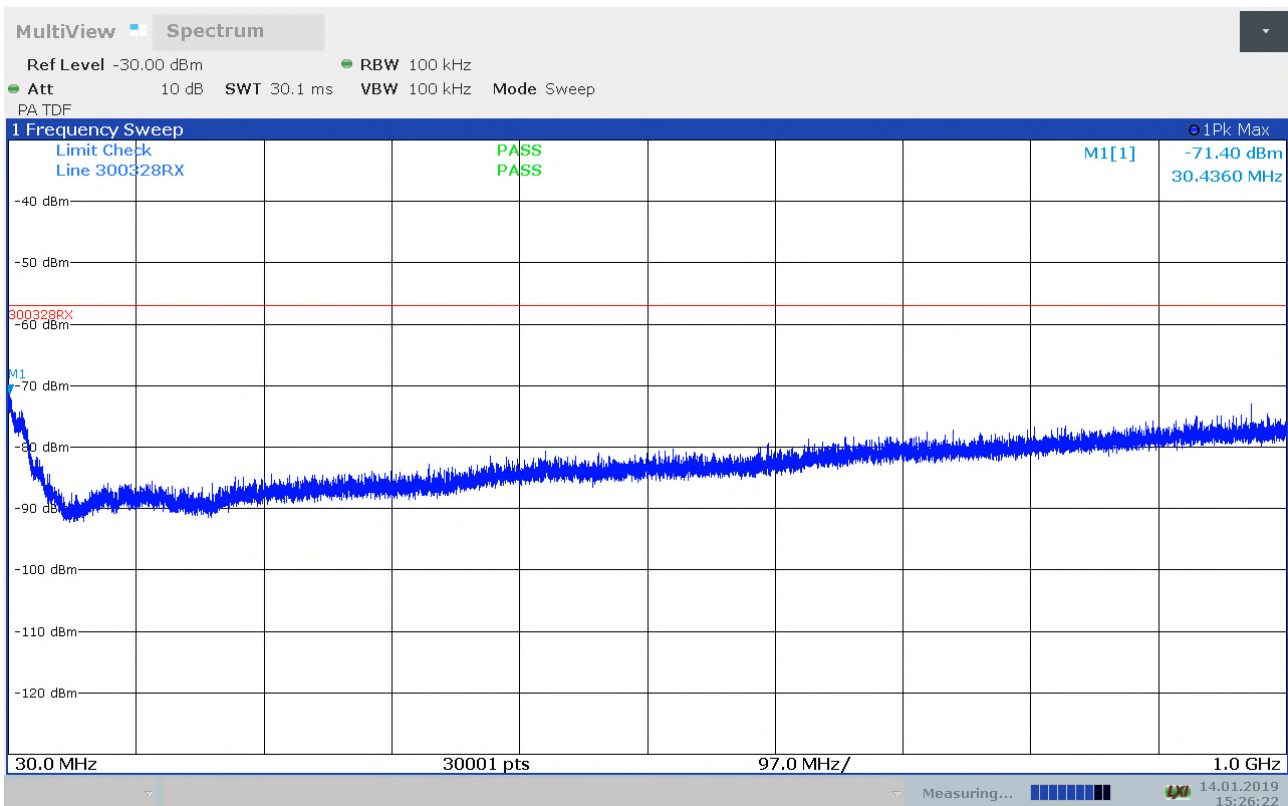
Limits: Clause 4.3.2.10.3

Frequency Range	Limit
30 MHz to 1 GHz	-57 dBm
above 1 GHz to 12,75 GHz	-47 dBm

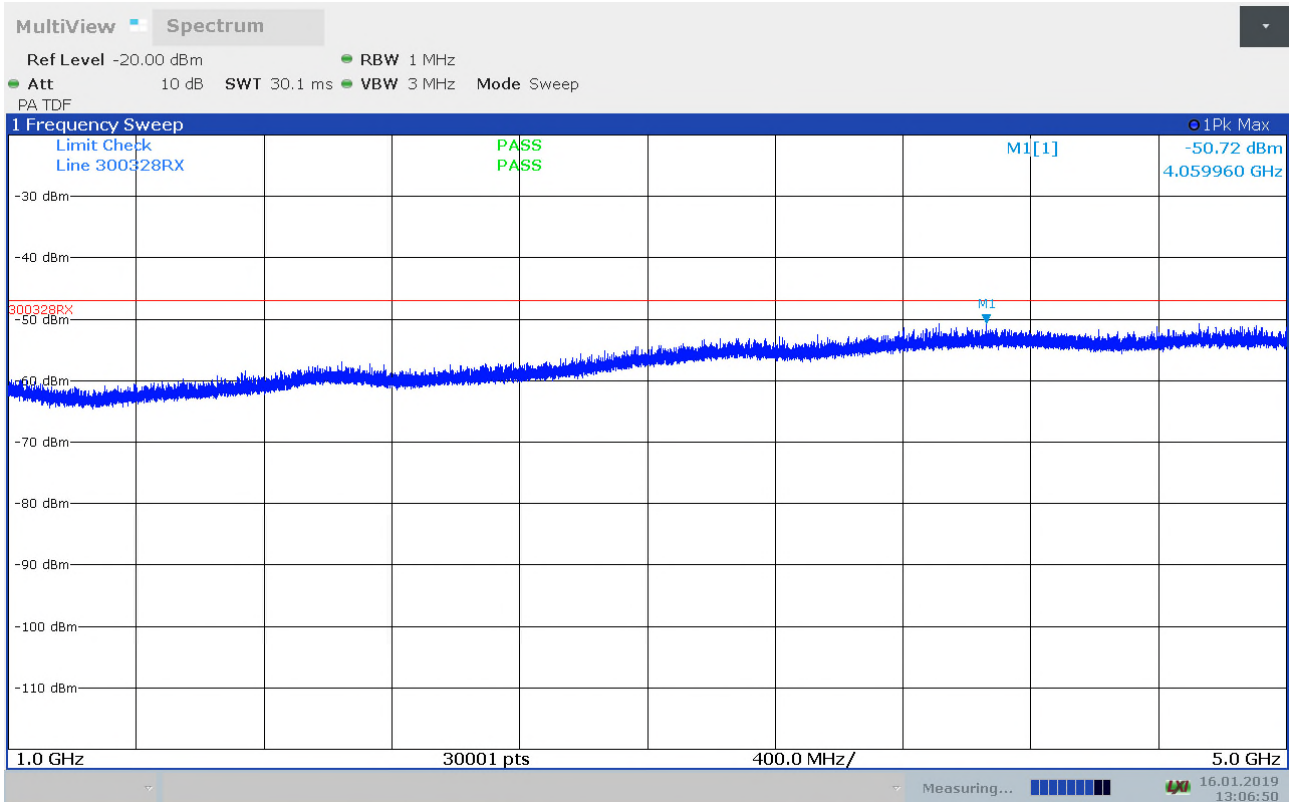
Test Equipment Used: 7,9,10,12,13



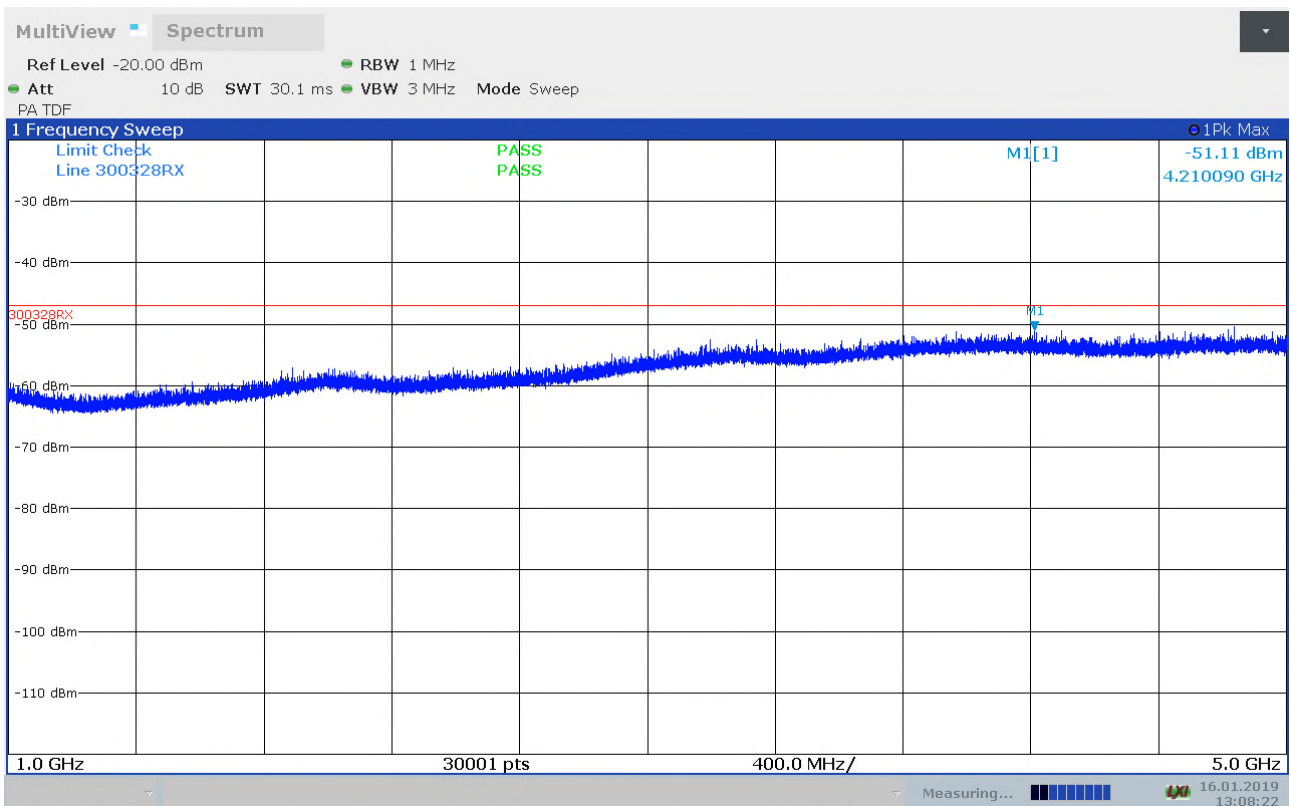
Receiver Emissions, radiated, 30 -1000 MHz, HP



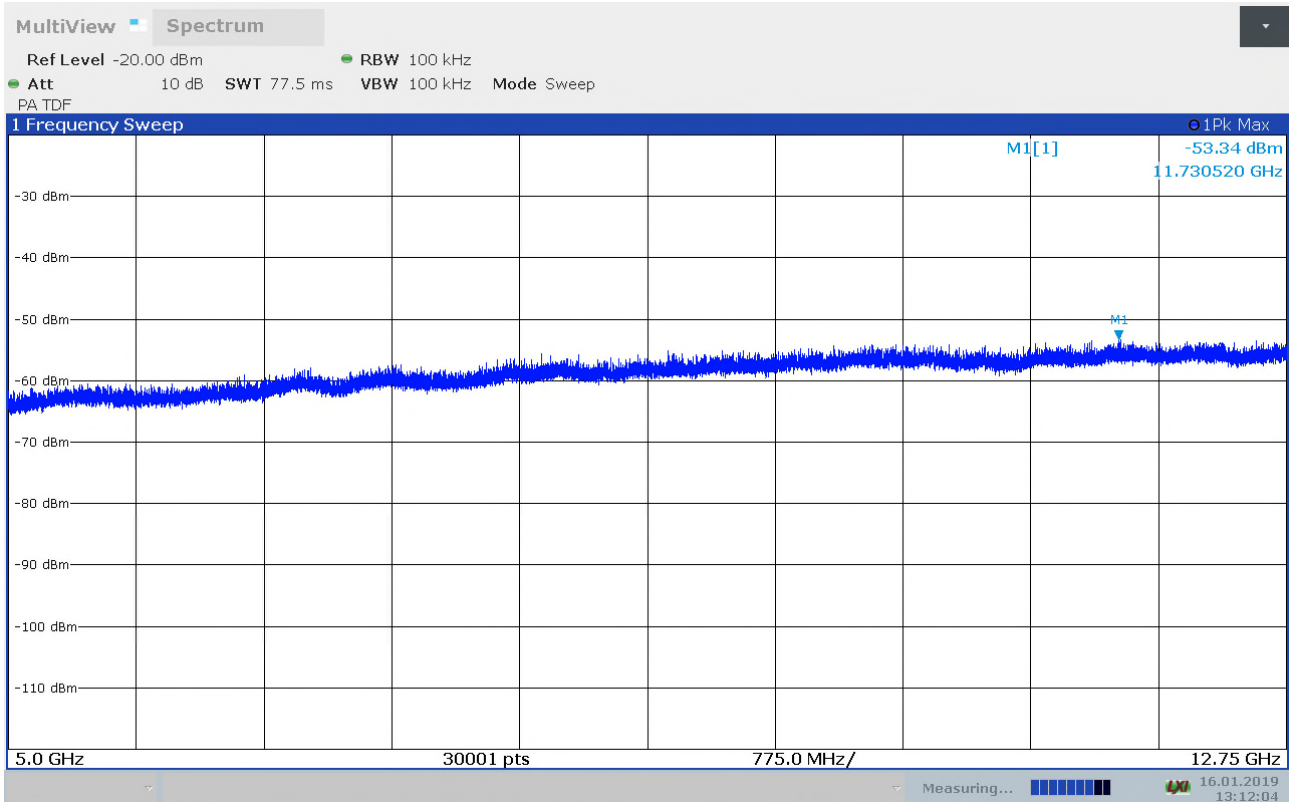
Receiver Emissions, radiated, 30 -1000 MHz, VP



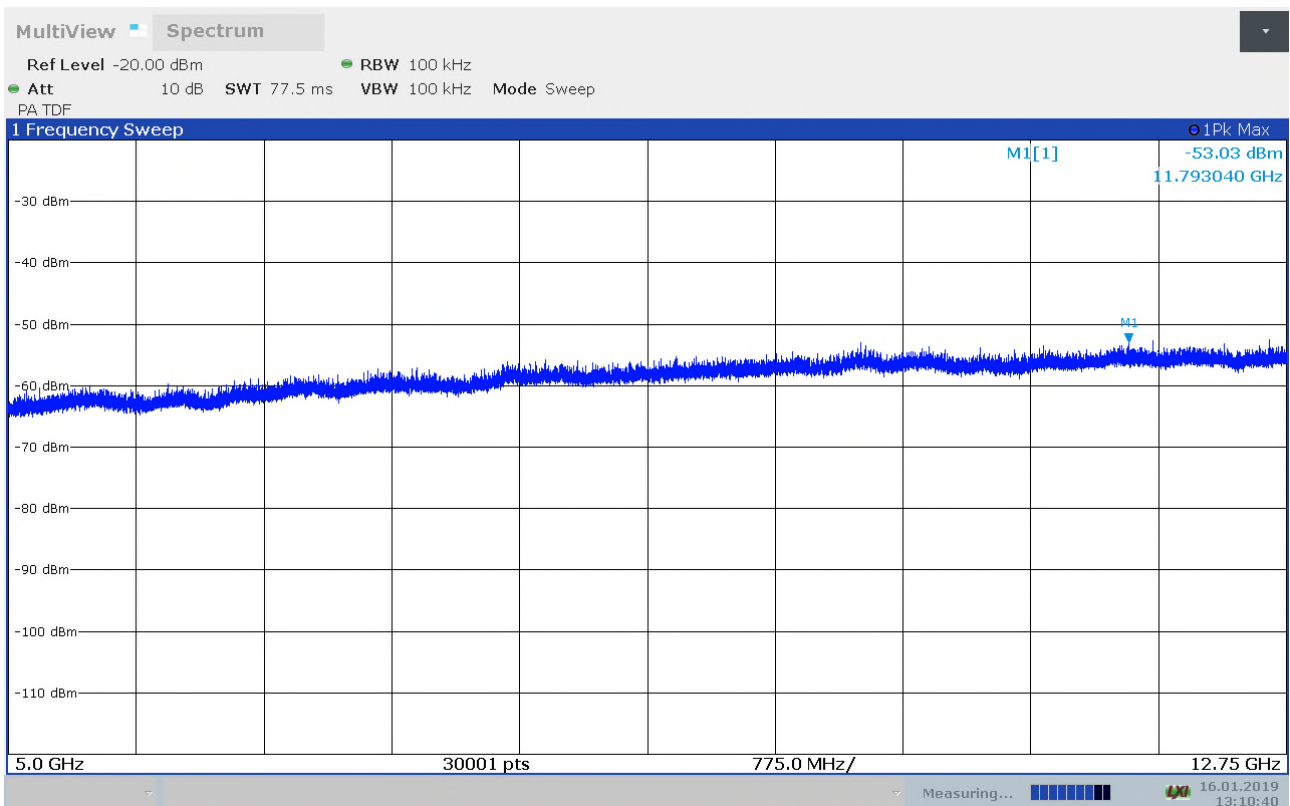
Receiver Emissions, radiated, 1 - 5GHz, ch2402MHz, HP



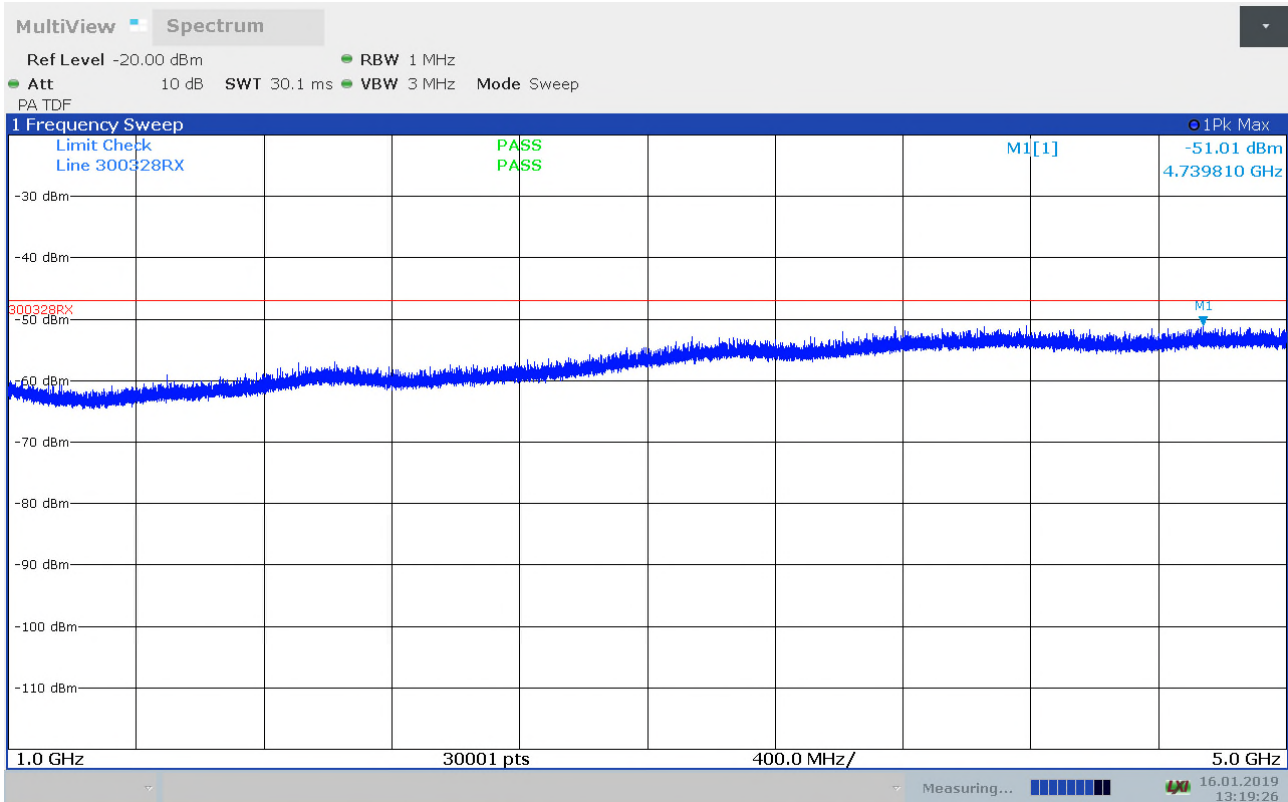
Receiver Emissions, radiated, 1 - 5GHz, ch2402MHz, VP



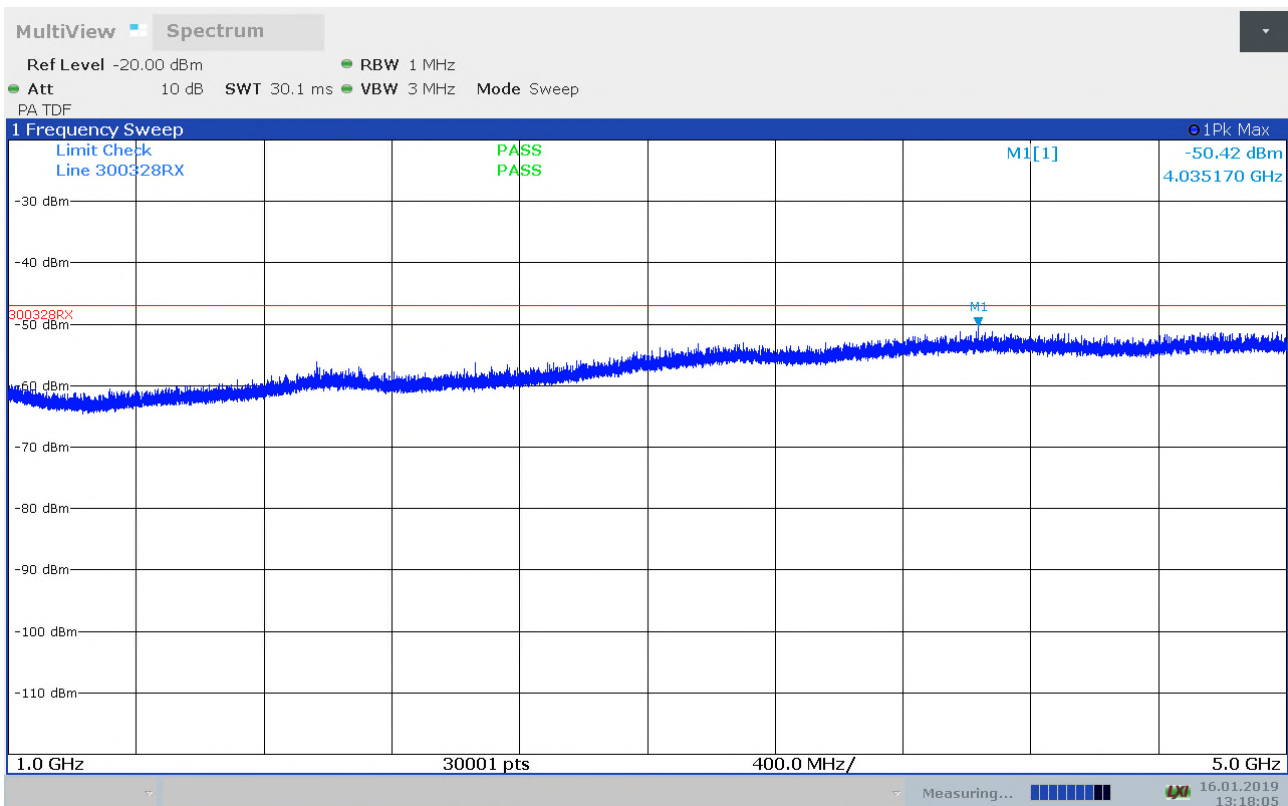
Receiver Emissions, radiated, 5 - 12.75GHz, ch2402MHz,HP, prescan



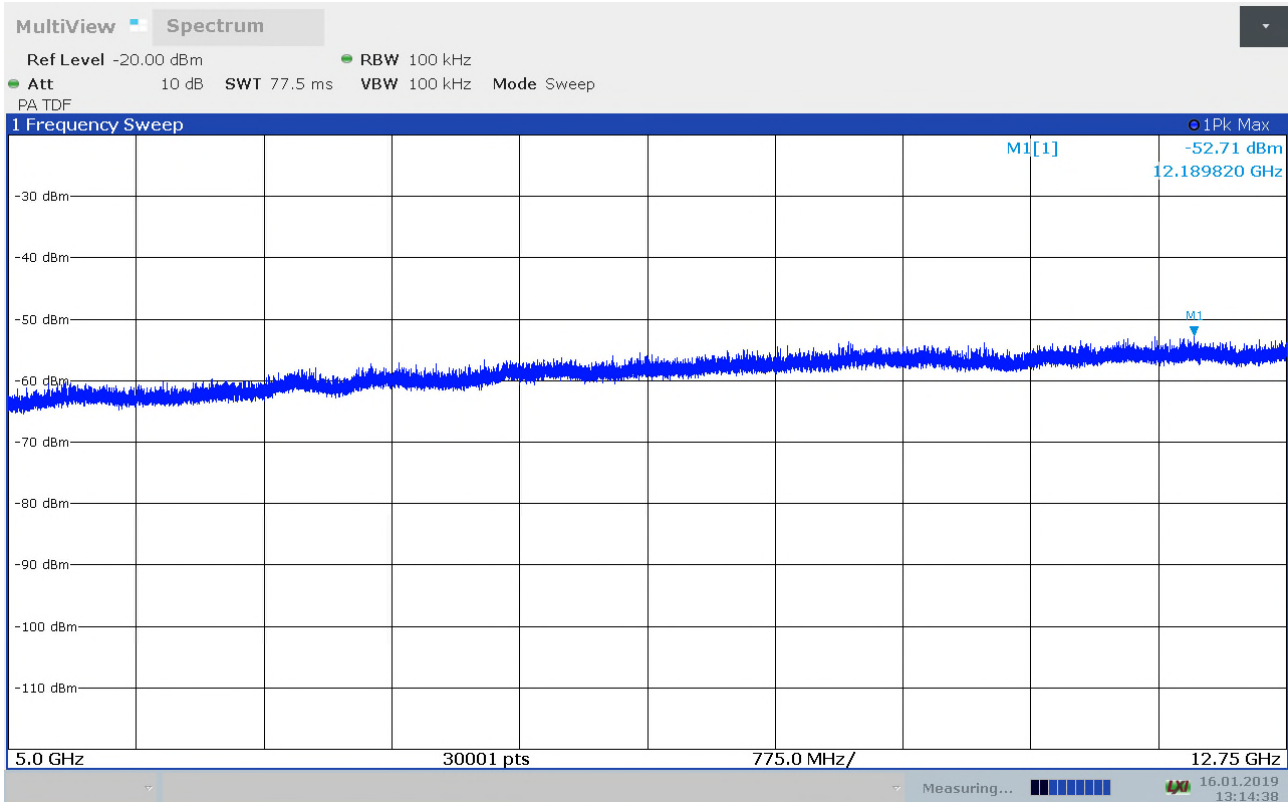
Receiver Emissions, radiated, 5 - 12.75GHz, ch2402MHz,VP, prescan



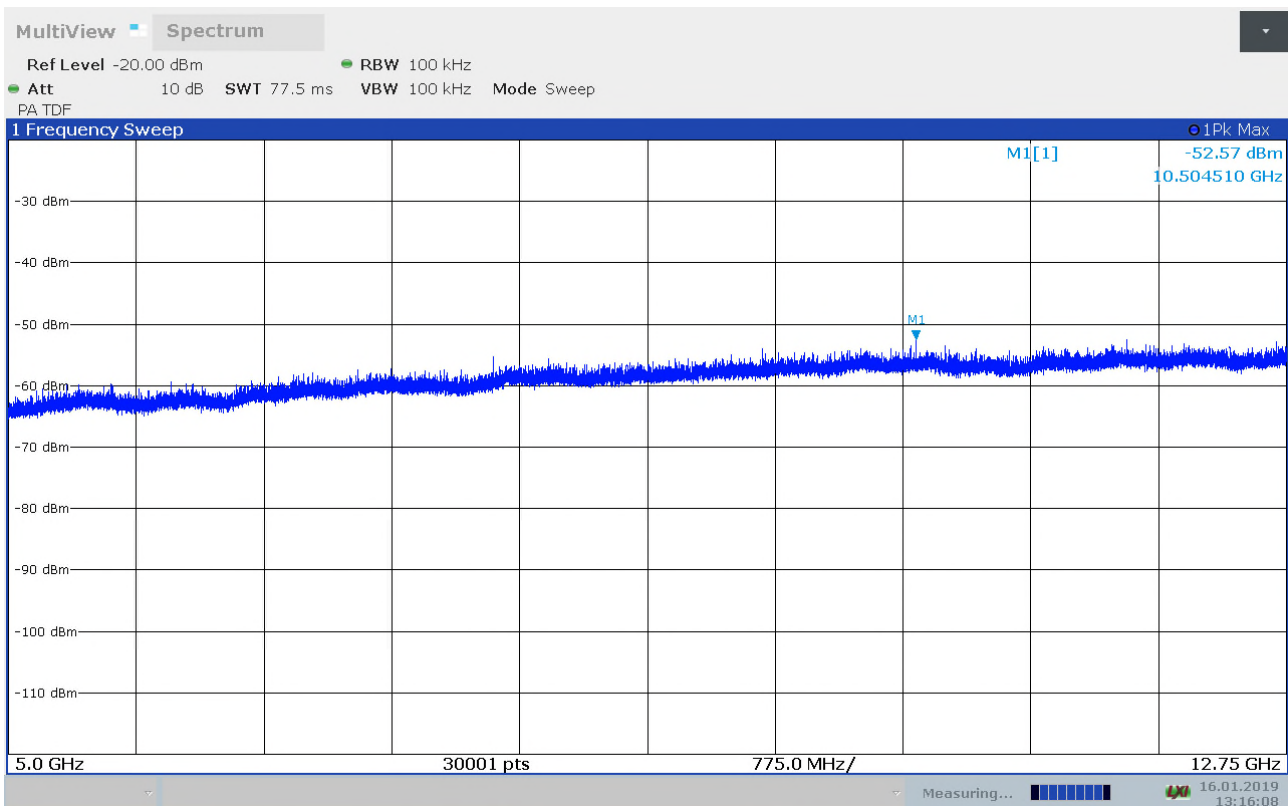
Receiver Emissions, radiated, 1 - 5GHz, ch2480MHz, HP



Receiver Emissions, radiated, 1 - 5GHz, ch2480MHz, VP



Receiver Emissions, radiated, 5 – 12.75GHz, ch2480MHz, HP, prescan



Receiver Emissions, radiated, 5 - 12.75GHz, ch2480MHz,VP, prescan

4.5 Geo-Location capability

ETSI EN 300 328 subclause 4.3.2.12

Description	Yes/NO
Geo-location capability implimented	NO

Requirements: Clause 4.3.2.12.3

The geographical location determined by the equipment as defined in cl. 4.3.2.12.2 shall not be accessible to the user.

5 Measurement Uncertainty

Measurement Uncertainty Values		
Test Item		Uncertainty
Conducted Output Power		±0.35 dB
Power Spectral Density		±3.7 dB
Out of Band Emissions, Conducted	< 1 GHz	±1.39 dB
	> 1 GHz	±1.39 dB
Spurious Emissions, Radiated	< 2 GHz	±1.1 dB
	> 2 GHz	±2.0 dB
Occupied Bandwidth		±0.1kHz
Timing/Duty cycle		< 0.5ns

Conducted measurements are given by the manufacturer (R&S TS8997)

6 Test Setups



Radiated measurements – XY plane



Radiated measurements – YZ plane



Radiated measurements – XZ plane

7 PHOTOGRAPHS OF THE EUT



Front view



Rear view

8 Test Equipment Used

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the testhouse.

No	Ref. No	Description	Manufacturer	Type	Cal. date	Cal. due
1.	LR 1654	Spectrum Analyzer	Rohde & Schwarz	FSV 30	01.2019	01.2020
2.	LR 1657	Power meter	Rohde & Schwarz	OSP –B157	01.2019	01.2020
3.	LR 1655	Vector Signal generator	Rohde & Schwarz	SMBV 100A	01.2019	01.2020
4.	LR 1656	Signal generator	Rohde & Schwarz	SMB100A	01.2019	01.2020
5.	-	EMC 32, TS8997 (Soft ware)	Rohde & Schwarz	V9.26.00/1.26.01	N/A	
6.	LR 1504	Spectrum Analyzer	Rohde & Schwarz	FSW26	01.2017	01.2019
7.	LR 1673	Attenuator	NARDA	4768-10	Cal b4 use	
8.	LR 1552	Pre-Amplifier	Miteq	JS4	10.2018	10.2019
9.	LR 1226	Double Ridged Horn Antenna	EMCO	3115	11.2013	11.2023
10.	LR 1614	Highpass Filter	Trilithic	6HC3000/18000	Cal b4 use	
11.	N-4525	Biconical-Log hybrid	Sunol Sciences	JB3	05.2018	05.2020
12.	LR1619	HP filter	Wainwright Instr.	WHKX6.5/18G-8	Cal b4 use	
13.	LR 102	Antenna, Horn	Sivers	PM7320X	12.2008	12.2020
14.	LR 101	Antenna, Horn	Systron	DBF-5230	12.2008	12.2020
15.	LR 1480	Antenna, Horn	Narda	638	12.2008	12.2020
16.	LR 1598	Multimeter, Digital	Fluke	87V	10.2018	10.2020

Revisions

Revision #	Date	Order #	Description
00	2019-03-04	362353	First issued
01	2019-05-10	362353	BT classic tested with high output power