

FCC LISTED, REGISTRATION
NUMBER: 720267

Informe de ensayo nº:
Test report No:

NIE: 46165RRF.005

Test report

USA FCC Part 15.247, 15.207, 15.209

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz,
and 5725 - 5850 MHz.

Identificación del objeto ensayado.....: Identification of item tested	CYCLING COMPUTER
Marca Trademark	Polar
Modelo y/o referencia tipo Model and /or type reference	1F
Other identification of the product	Commercial name: POLAR M450 FCC ID: INW1F
Final HW version	00755840.01
Final SW version	0.12.8
Características Features	Bluetooth Low Energy, GPS
Fabricante Manufacturer	POLAR ELECTRO OY Professorintie 5, 90440 Kempele. Finland.
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 15.247 10-1-14 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.207 10-1-14 Edition: Conducted limits. USA FCC Part 15.209 10-1-14 Edition: Radiated emission limits; general requirements. Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r02 dated 05/06/2014. ANSI C63.4-2009: American National Standard for Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz ANSI C63.10-2009: American National Standard for Testing Unlicensed Wireless Devices.
Resultado.....: Summary	IN COMPLIANCE
Aprobado por (nombre / cargo y firma) Approved by (name / position & signature)	A. Llamas RF Lab. Manager
Fecha de realización Date of issue	2015-05-25
Formato de informe No.: Report template No	FDT08_16

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Competences and guarantees

AT4 wireless is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

In order to assure the traceability to other national and international laboratories, AT4 wireless has a calibration and maintenance program for its measurement equipment.

AT4 wireless guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at AT4 wireless at the time of performance of the test.

AT4 wireless is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

IMPORTANT: No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of AT4 wireless.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of AT4 wireless and the Accreditation Bodies.

Uncertainty

Uncertainty (factor $k=2$) was calculated according to the AT4 wireless internal document PODT000.

Usage of samples

Samples undergoing test have been selected by: **the client**

Sample M/01 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
46165/009	Bluetooth device with integral antenna	1F	F5151F0500298	2015-05-06

1. Sample M/01 has undergone following test(s).
All radiated tests indicated in appendix A.

Sample M/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
46165/010	Bluetooth device with antenna connector	1F	F5151F0500294	2015-05-06

1. Sample M/02 has undergone the test(s) specified in subclause “Test method requested”.

All conducted tests indicated in appendix A.

Test sample description

The test sample consists of a Cycling Computer.

Identification of the client

POLAR ELECTRO OY

Professorintie 5, 90440 Kempele. Finland.

Testing period

The performed test started on 2015-05-06 and finished on 2015-05-08.

The tests have been performed at AT4 wireless.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

In the semianechoic chamber (21 meters x 11 meters x 8 meters), the following limits were not exceeded during the test.

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

Remarks and comments

1: Used instrumentation:

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum Analyzer Agilent E4440A	2014/05	2016/05
2.	DC power supply R&S NGPE 40/40	2014/11	2017/11

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2.	BiconicalLog antenna ETS LINDGREN 3142E	2014/03	2017/03
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2013/11	2016/11
5.	Double-ridge Guide Horn antenna 14- 40 GHz SCHWARZBECK BBHA 9170	2014/03	2017/03
6.	EMI Test Receiver R&S ESU 26	2013/08	2015/08
7.	Spectrum analyser Rohde & Schwarz FSW50	2013/10	2015/10
8.	RF pre-amplifier 10 MHz-6 GHz SCHWARZBECK BBV9743	2015/03	2016/03
9.	RF pre-amplifier 1-18 GHz Schwarzbeck BBV 9718	2015/02	2016/02
10.	RF pre-amplifier BONN BLMA 1840- 1M 18-40 GHz.	2014/02	2016/02

Testing verdicts

Not applicable	N/A
Pass	P
Fail	F
Not measured	N/M

FCC PART 15 PARAGRAPH		VERDICT			
		NA	P	F	NM
Section 15.247 Subclause (a) (2)	6 dB Bandwidth		P		
Section 15.247 Subclause (b)	Maximum output power and antenna gain		P		
Section 15.247 Subclause (d)	Emission limitations conducted (Transmitter)		P		
Section 15.247 Subclause (d)	Band-edge emissions compliance (Transmitter)		P		
Section 15.247 Subclause (e)	Power spectral density		P		
Section 15.247 Subclause (d)	Emission limitations radiated (Transmitter)		P		
Section 15.207.	Conducted limits		P		

Appendix A – Test result

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TEST CONDITIONS

Power supply (V):

$$V_{\text{nominal}} = 3.8 \text{ Vdc}$$

Type of power supply = DC voltage from battery.

Type of antenna = Integral antenna.

Declared Gain for antenna (maximum) = 3.5 dBi

TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2440 MHz

Highest channel: 2480 MHz

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is directly connected to the spectrum analyzer.

RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive (wooden) platform one meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

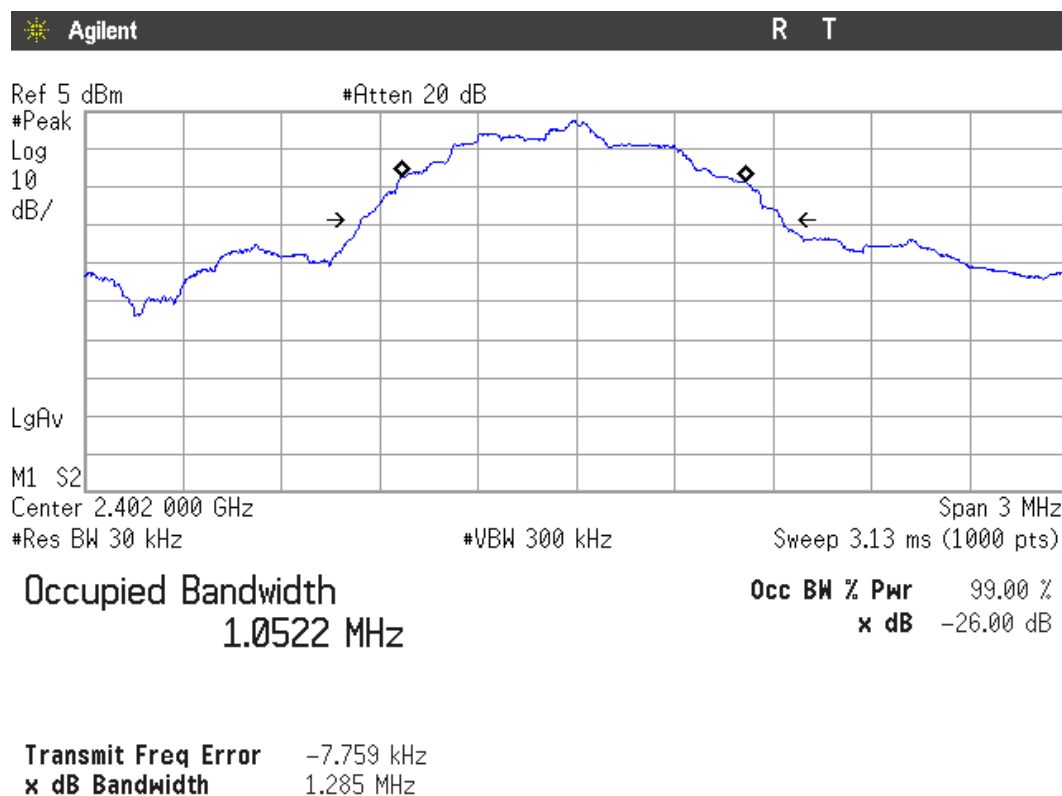
Occupied Bandwidth

RESULTS

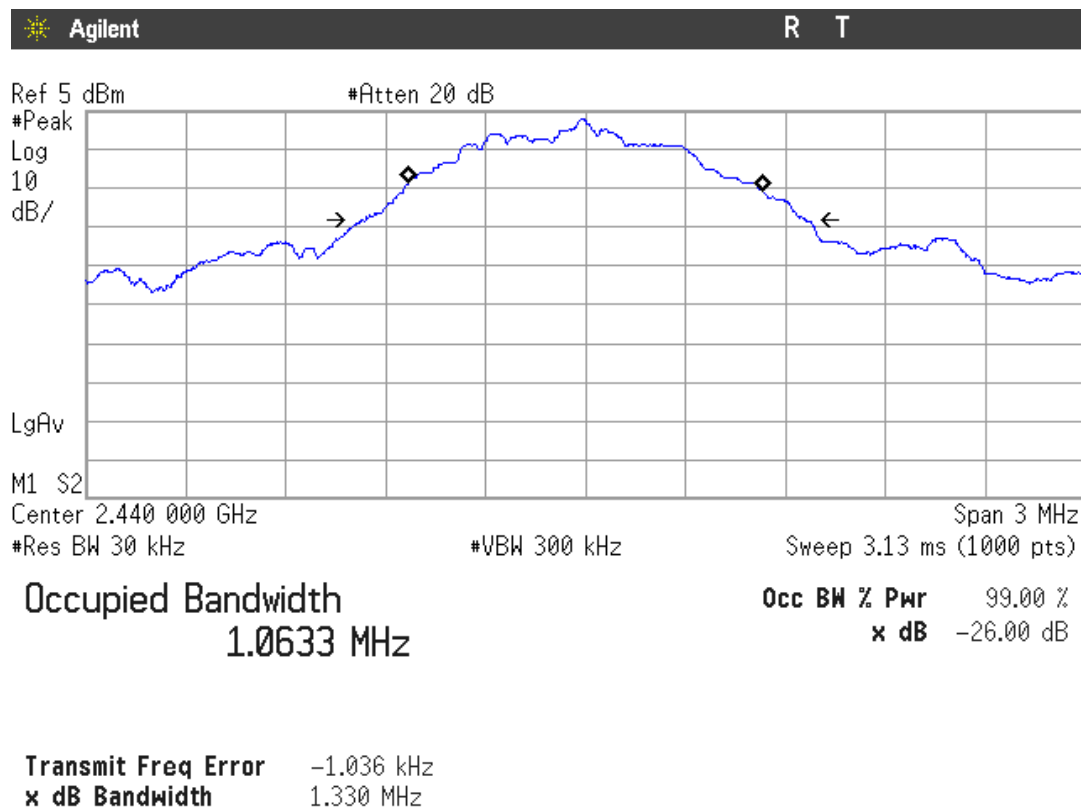
(see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
99% bandwidth (MHz)	1.0522	1.0633	1.1337
-26 dBc bandwidth (MHz)	1.285	1.330	1.428
Measurement uncertainty (kHz)	±21.7		

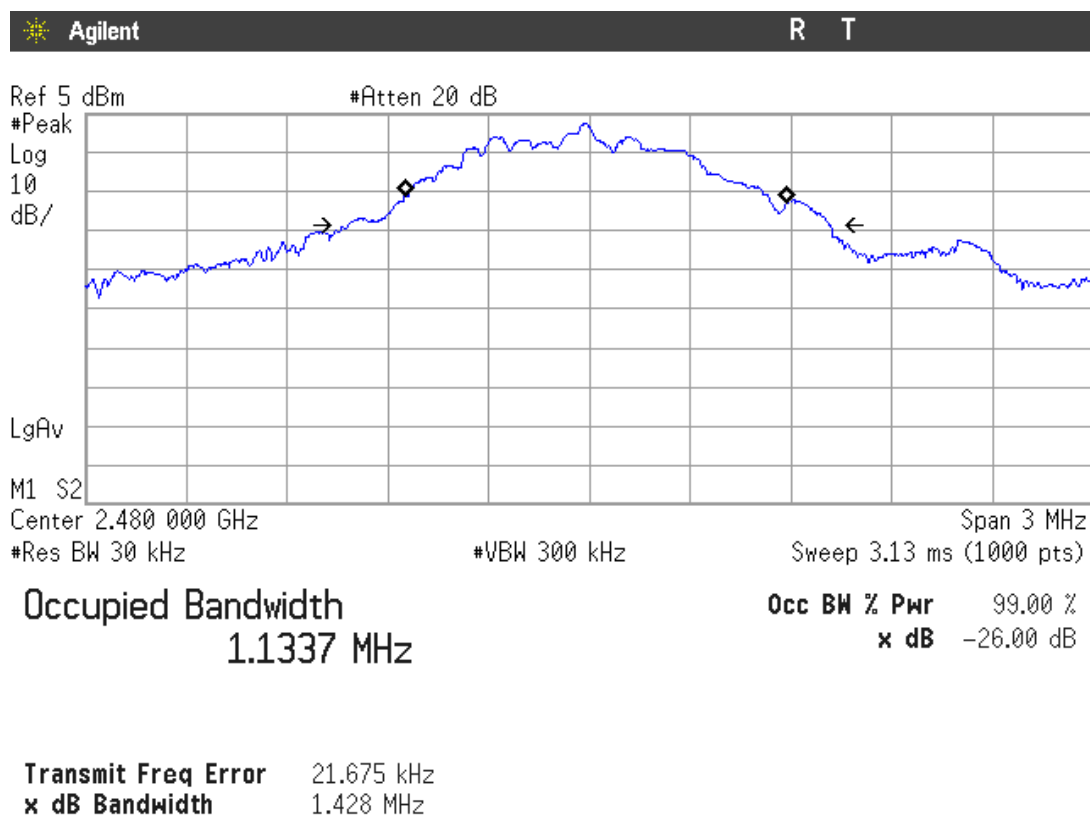
Lowest Channel



Middle Channel



Highest channel



Section 15.247 Subclause (a) (2). 6 dB Bandwidth

SPECIFICATION

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

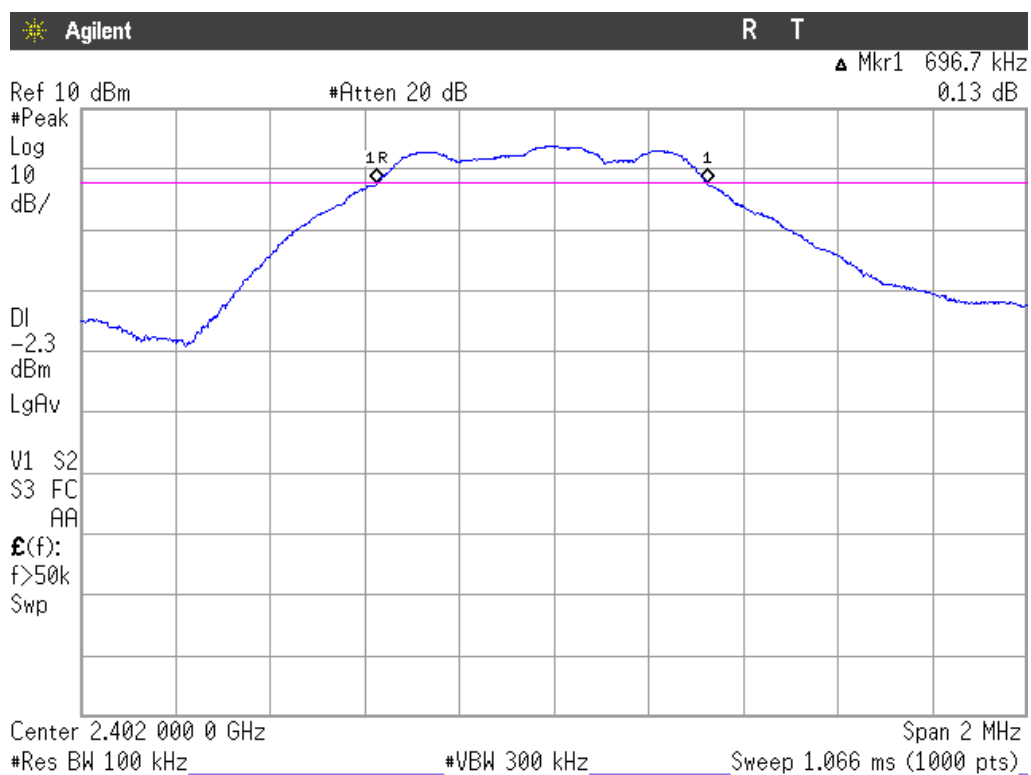
6 dB Bandwidth (see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
6 dB Spectrum bandwidth (kHz)	696.7	706.7	714.7
Measurement uncertainty (kHz)	±21.7		

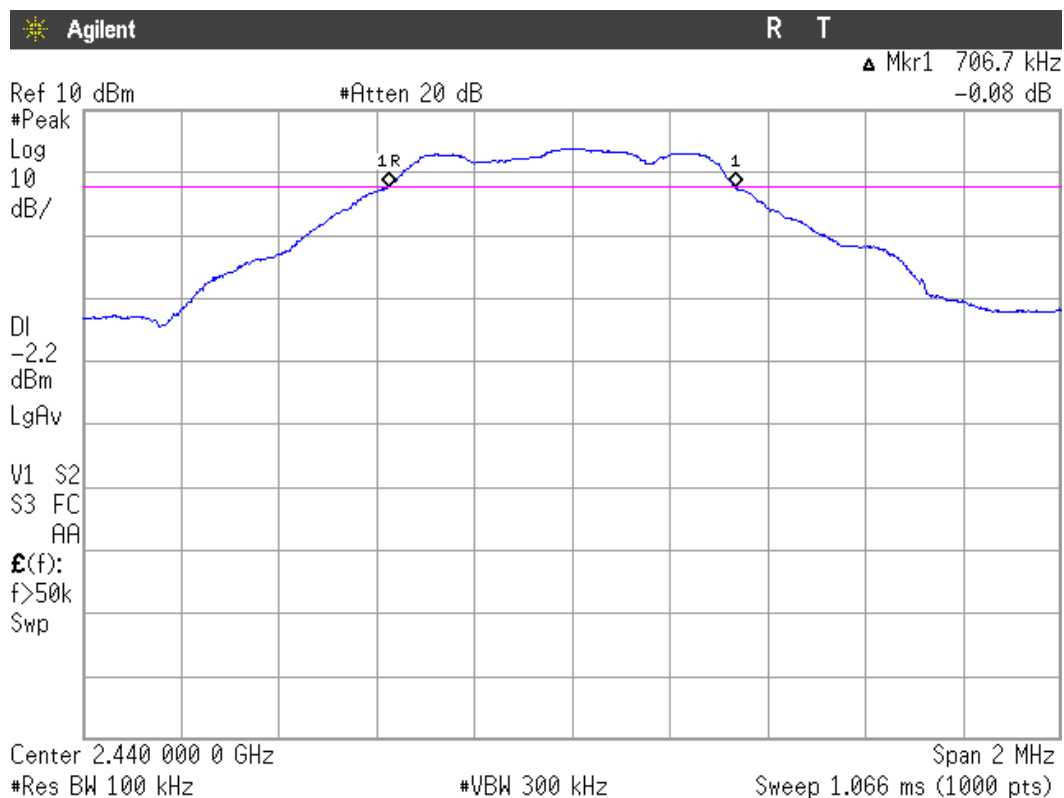
Verdict: PASS

6 dB BANDWIDTH.

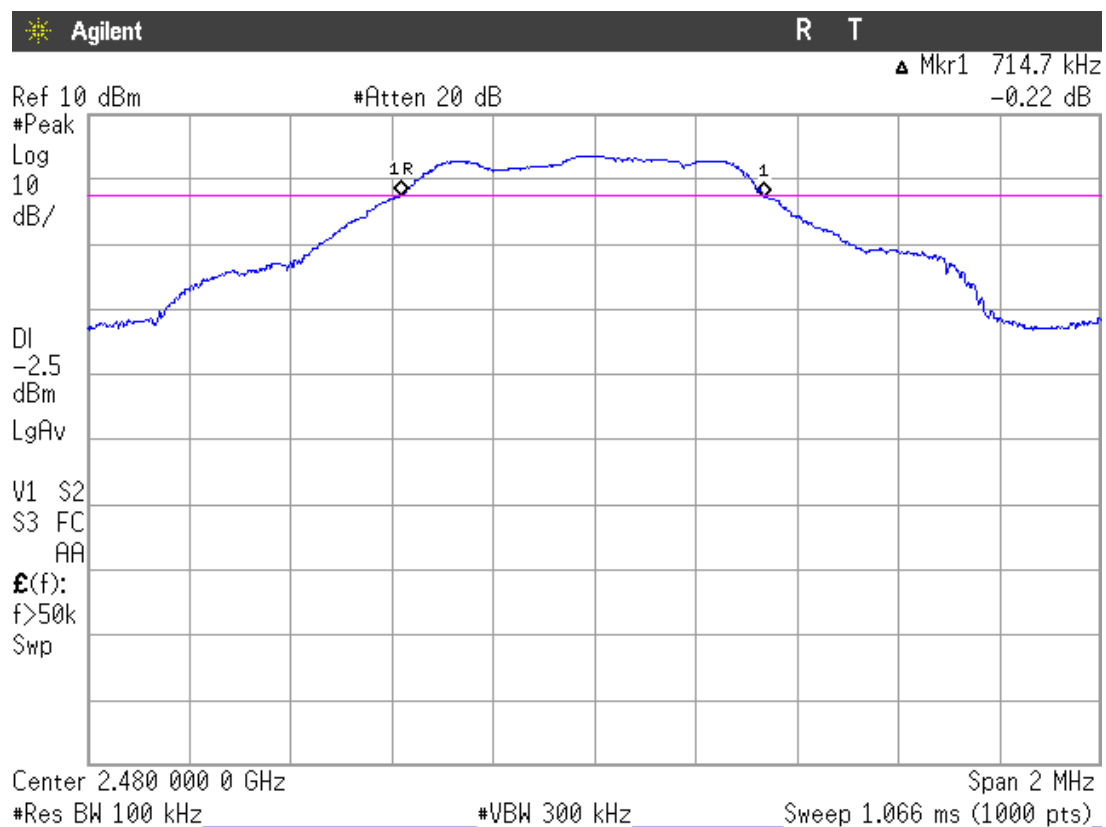
Lowest Channel



Middle Channel



Highest Channel



Section 15.247 Subclause (b). Maximum output power and antenna gain

SPECIFICATION

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).

RESULTS

The maximum peak conducted output power was measured using the method according to point 9.1.1. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r02 dated 05/06/2014.

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

MAXIMUM OUTPUT POWER. See next plots.

Maximum declared antenna gain: 3.5 dBi.

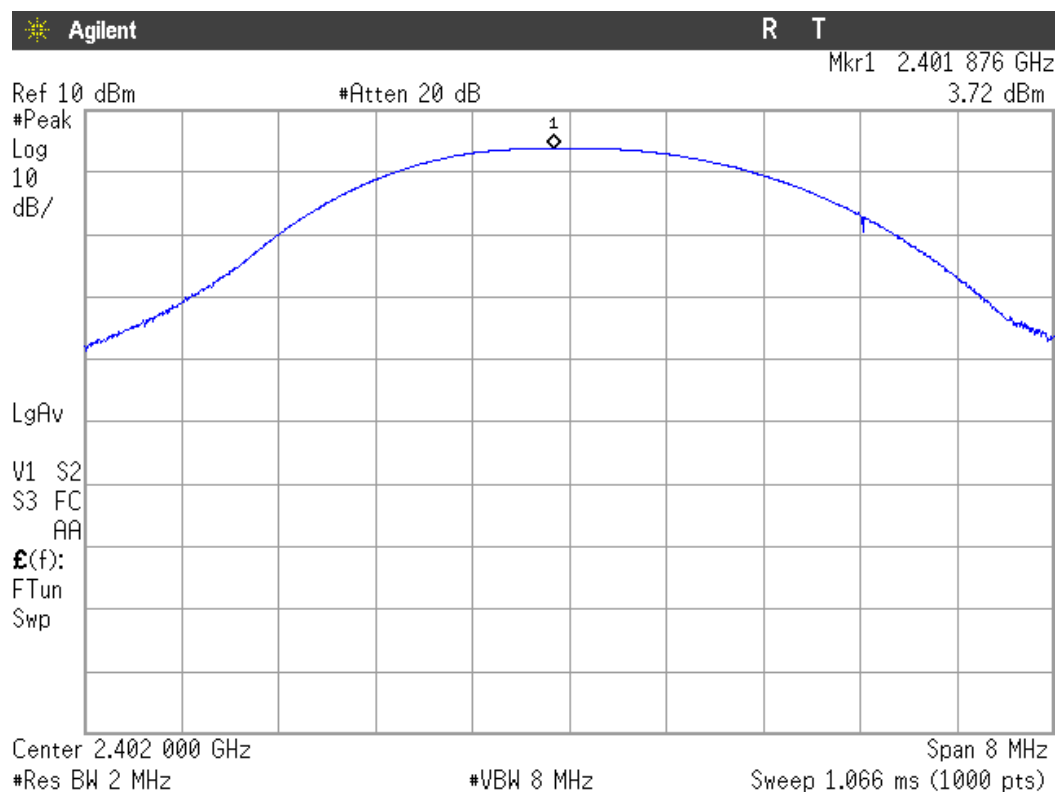
	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Maximum conducted power (dBm)	3.72	3.81	3.59
Maximum EIRP power (dBm)	7.22	7.31	7.09
Measurement uncertainty (dB)	±1.5		

The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

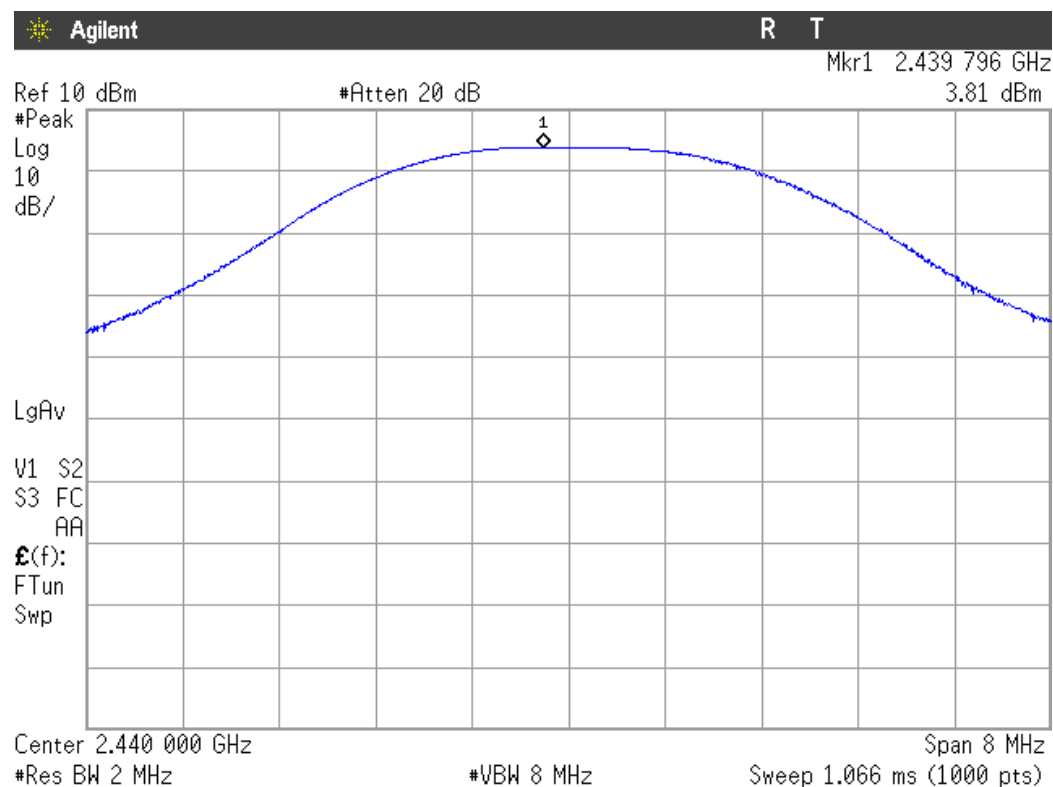
Verdict: PASS

CONDUCTED PEAK POWER.

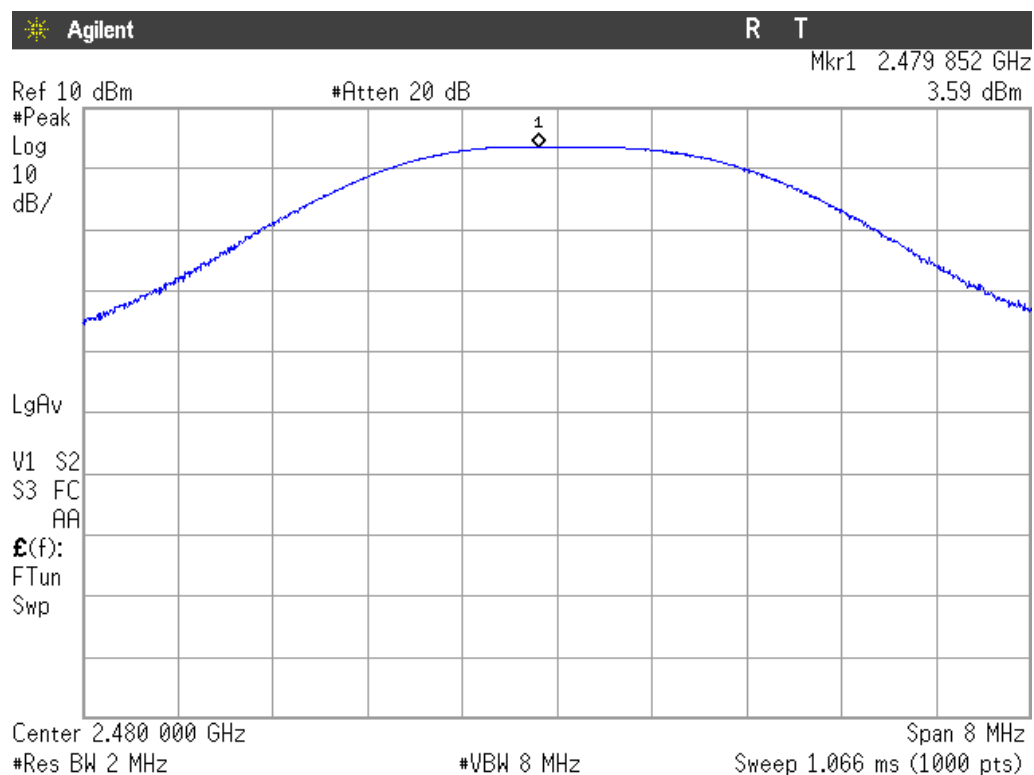
Lowest frequency



Middle frequency



Highest frequency



Section 15.247 Subclause (d). Emission limitations conducted (Transmitter)

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

RESULTS:

Reference Level Measurement

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Reference Level Measurement (dBm)	3.65	3.75	3.52
Measurement uncertainty (dB)	±1.5		

Lowest frequency 2402 MHz

All peaks are more than 20 dB below the limit.

Middle frequency 2440 MHz

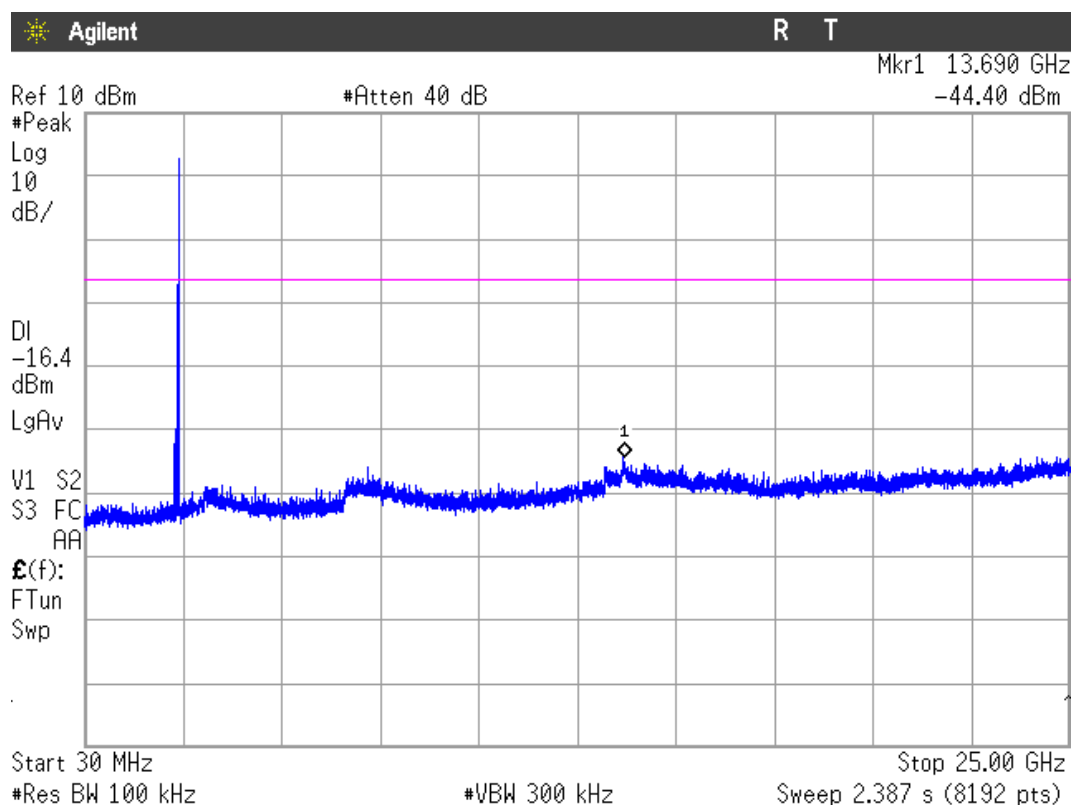
All peaks are more than 20 dB below the limit.

Highest frequency 2480 MHz

All peaks are more than 20 dB below the limit.

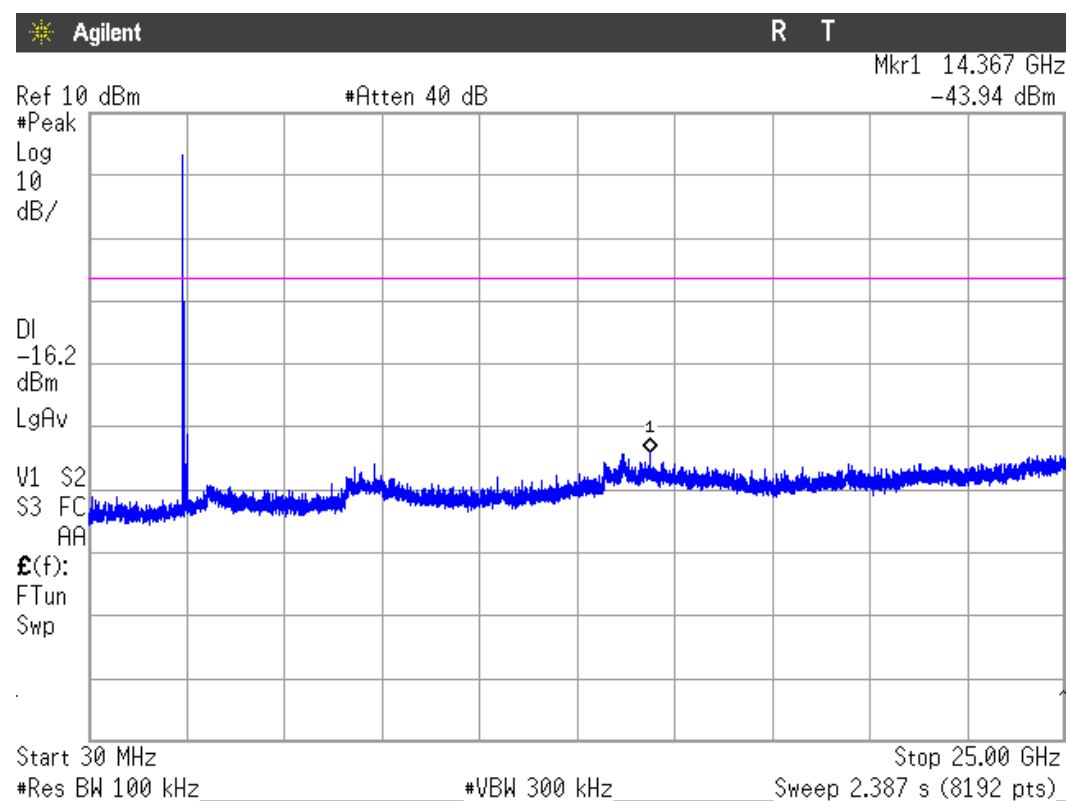
Verdict: PASS

Lowest frequency (2402 MHz)



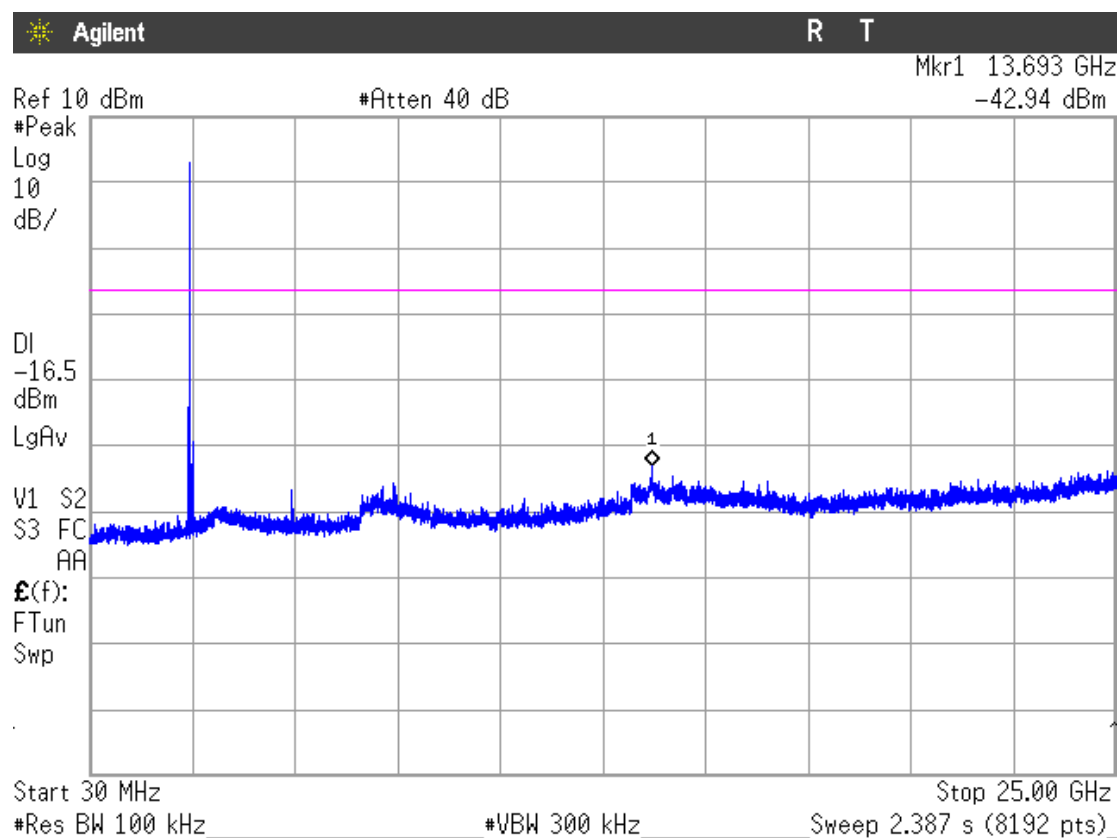
Note: The peak above the limit is the carrier frequency.

Middle frequency (2440 MHz)



Note: The peak above the limit is the carrier frequency.

Highest frequency (2480 MHz)



Note: The peak above the limit is the carrier frequency.

Section 15.247 Subclause (d). Band-edge emissions compliance (Transmitter)

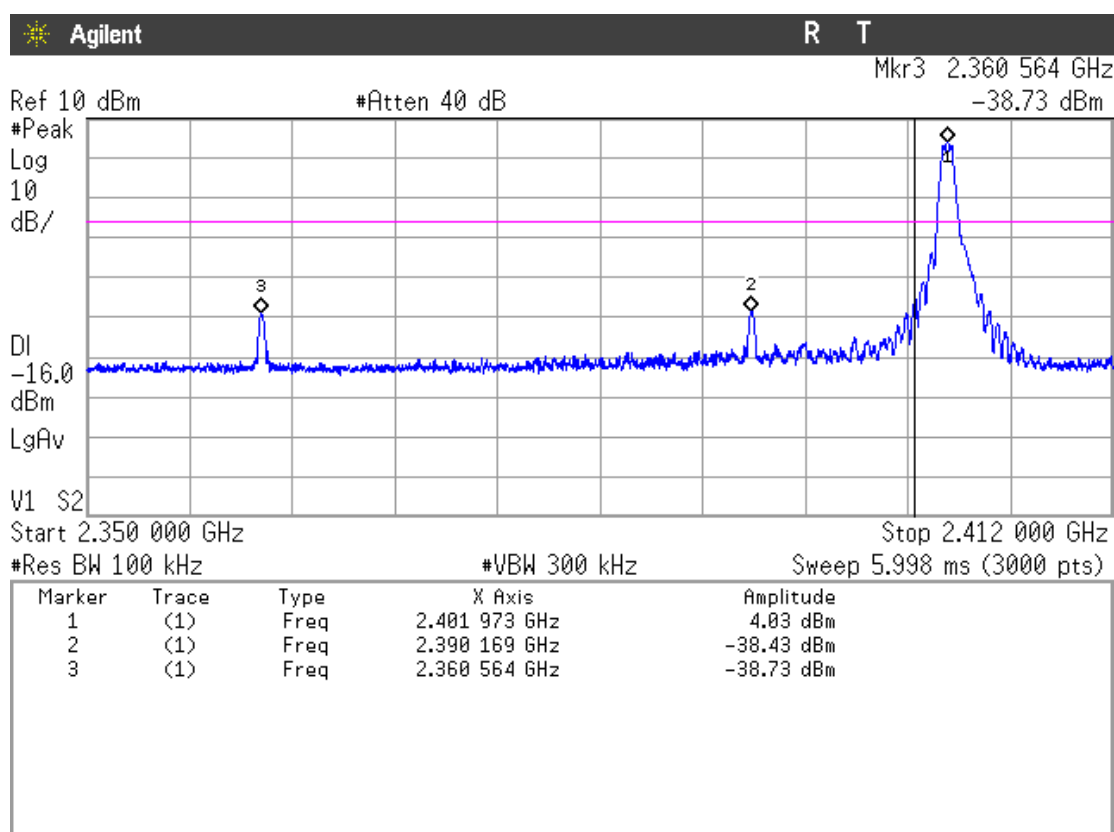
SPECIFICATION

Emissions outside the frequency band in which the intentional radiator is operating shall be at least 20dB below the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

RESULTS:

1. LOW FREQUENCY SECTION. CONDUCTED.

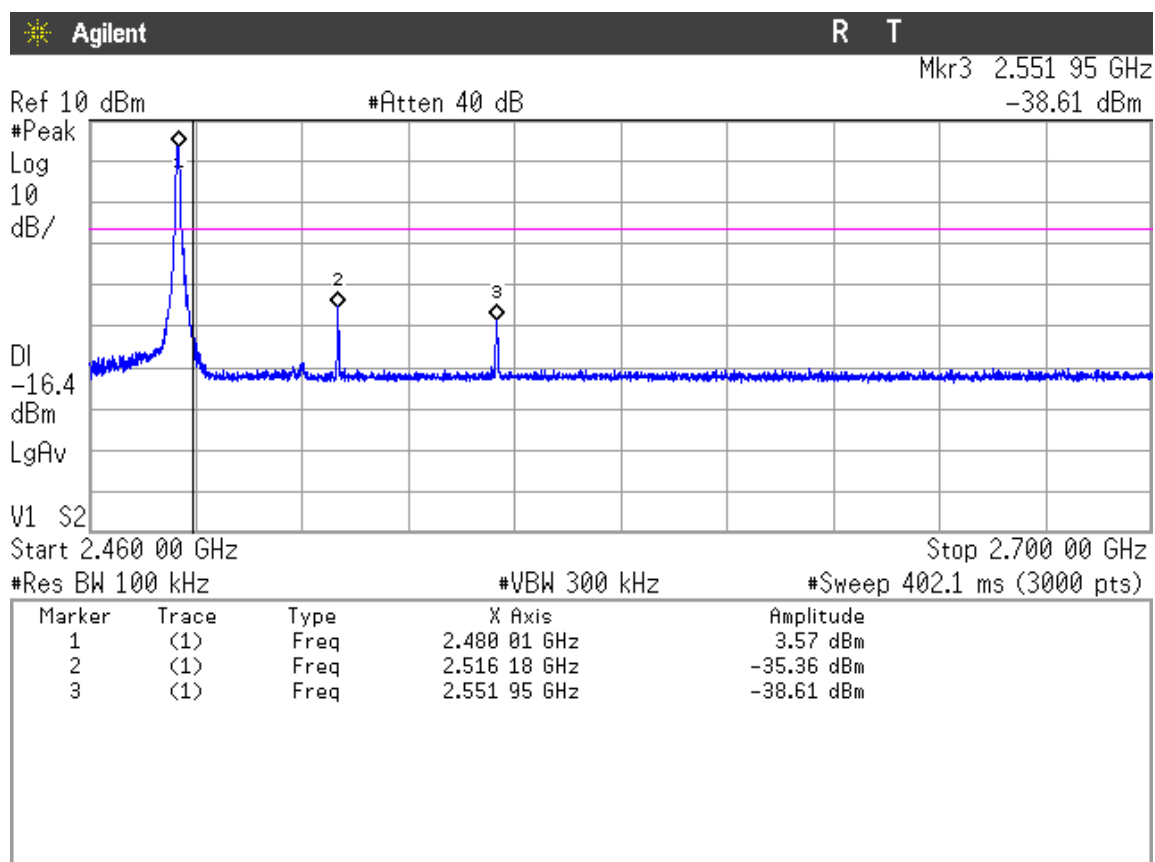
See next plot.



Verdict: PASS

2. HIGH FREQUENCY SECTION. CONDUCTED.

See next plot.



Verdict: PASS

Section 15.247 Subclause (e). Power spectral density

SPECIFICATION

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS

The maximum power spectral density level in the fundamental emission was measured using the method PKPSD (Peak PSD) according to point 10.2. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v03r02 dated 05/06/2014.

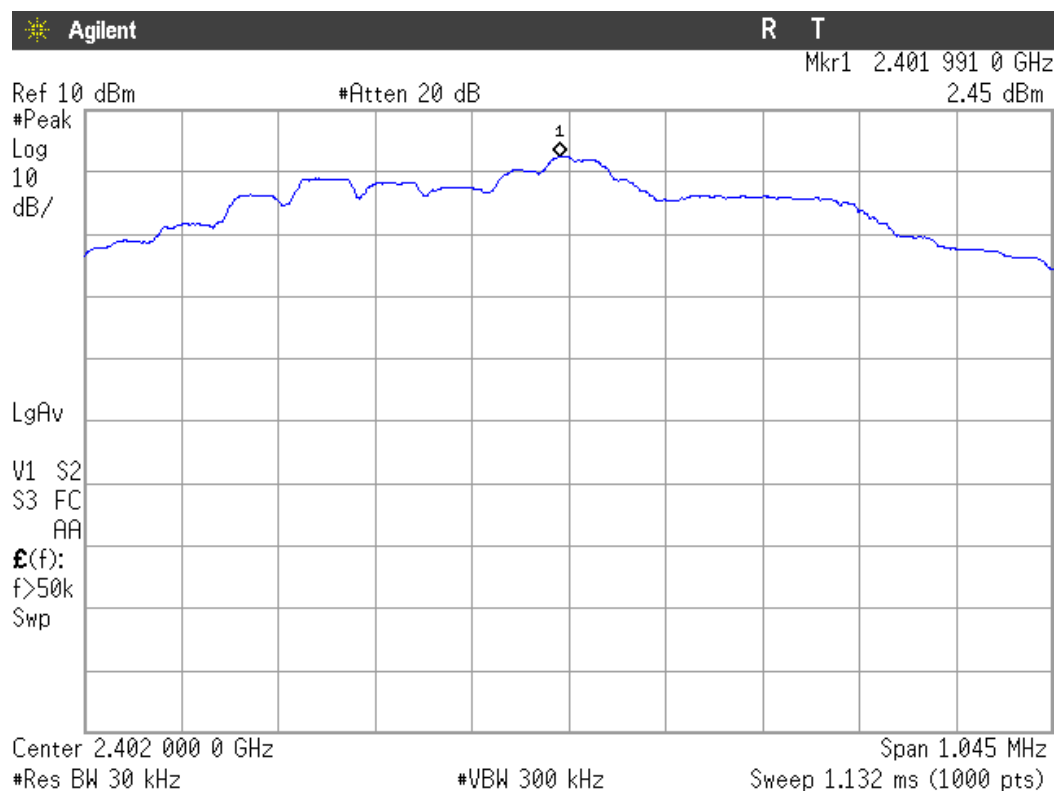
Power spectral density (see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Power spectral density (dBm)	2.45	2.81	2.35
Measurement uncertainty (dB)	±1.5		

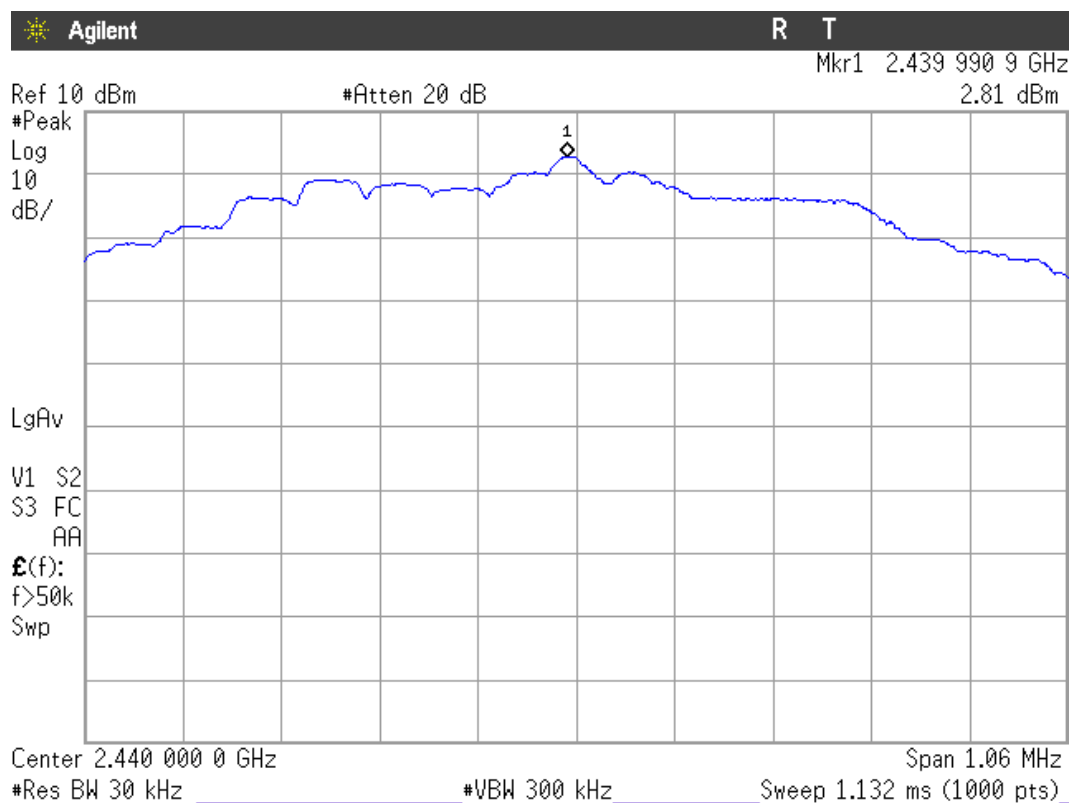
Verdict: PASS

Power spectral density.

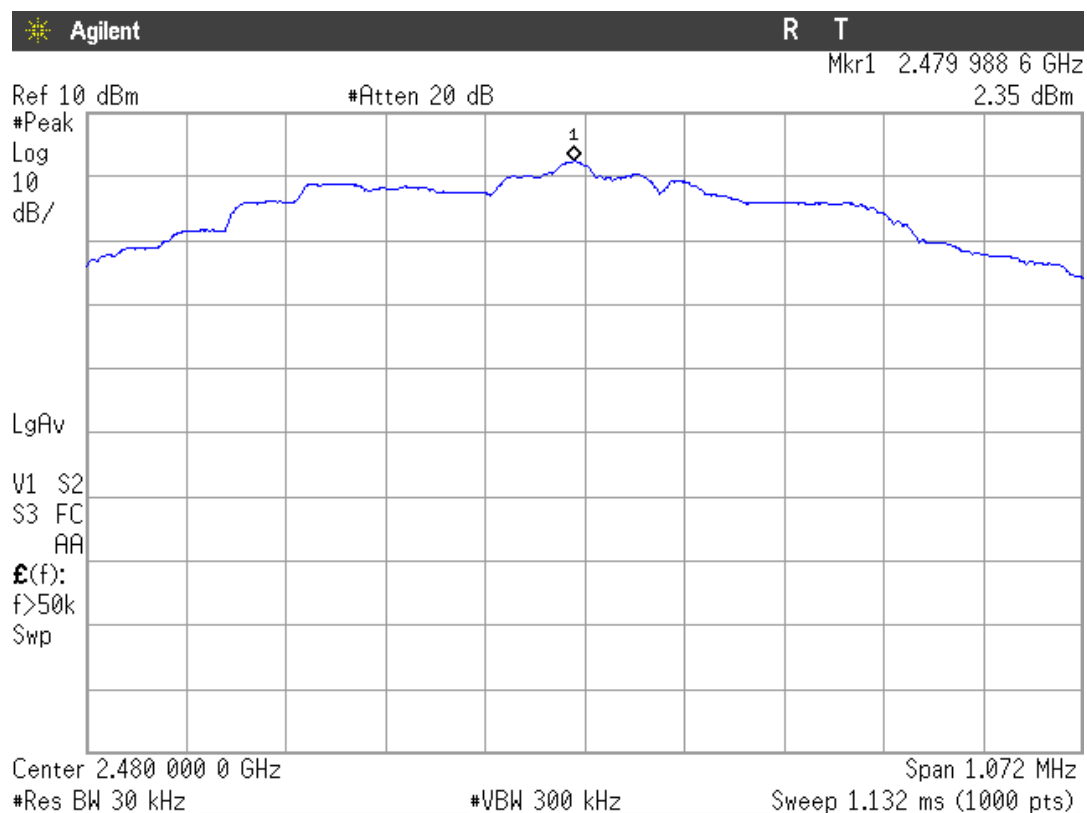
Lowest Channel



Middle Channel



Highest Channel



Section 15.247 Subclause (d). Emission limitations radiated (Transmitter)

SPECIFICATION

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)):

Frequency Range (MHz)	Field strength ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	300
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-1000 MHz and at distance of 1m for the frequency range 1 GHz-25 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz-1000 MHz.

The spurious signals detected do not depend on the operating channel.

All peaks are more than 20 dB below the limit.

Frequency range 1 GHz-25 GHz

The results in the next tables show the maximum measured levels in the 1-25 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz (see next plots).

Spurious signals with peak levels above the average limit (54 dB μ V/m at 3 m) are measured with RMS detector for checking compliance with the average limit.

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
2.31000	V	Peak	53.21	± 4.00
2.36460	V	Peak	57.38	± 4.00
		RMS	42.24	± 4.00
2.42495	V	Peak	58.15	± 4.00
		RMS	50.74	± 4.00
4.80425	V	Peak	39.12	± 4.00
7.20575	H	Peak	45.49	± 4.00
9.60825	H	Peak	45.81	± 4.00

2. CHANNEL: MIDDLE (2440 MHz).

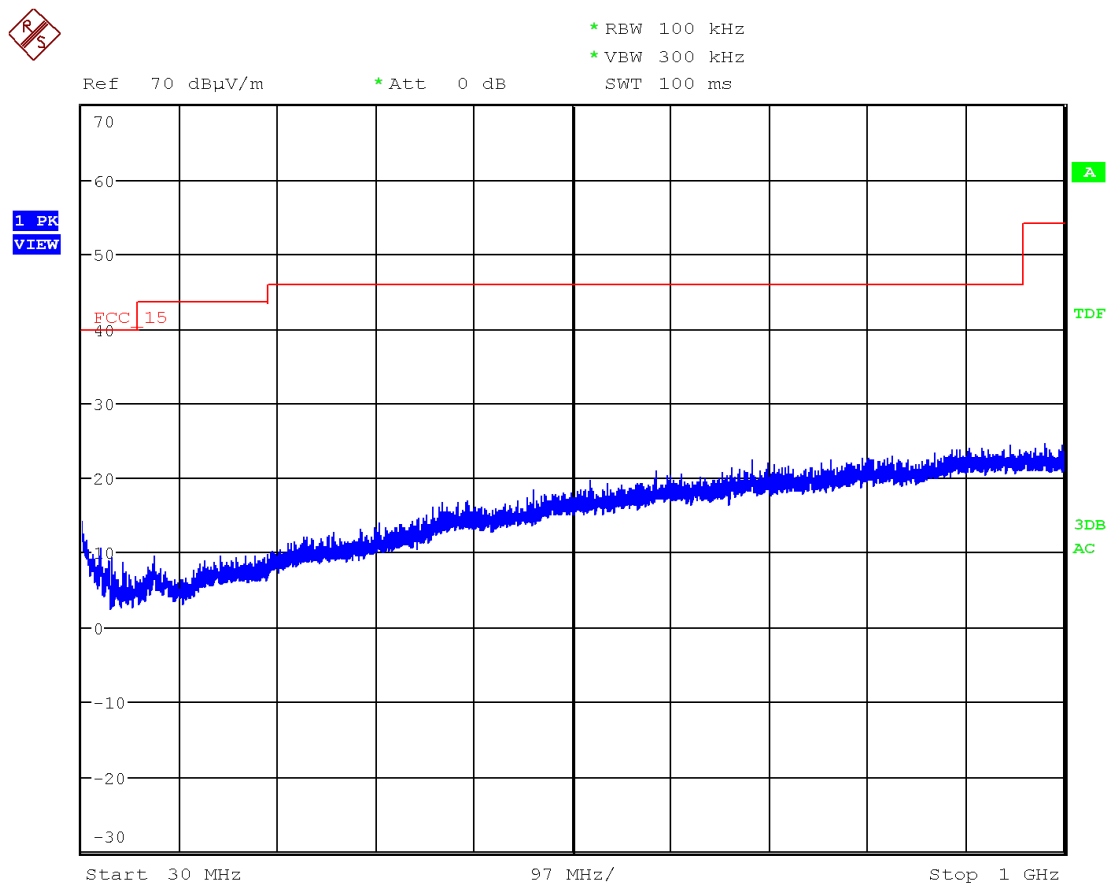
Spurious frequency (GHz)	Polarization	Detector	Emission Level (dB μ V/m)	Measurement Uncertainty (dB)
2.48655	V	Peak	59.86	± 4.00
		RMS	44.90	± 4.00
2.55548	H	Peak	53.44	± 4.00
2.55573	V	Peak	58.52	± 4.00
		RMS	48.25	± 4.00
4.87975	V	Peak	38.75	± 4.00
7.32075	H	Peak	47.37	± 4.00
9.76075	H	Peak	46.99	± 4.00

3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBμ V/m)	Measurement Uncertainty (dB)
2.42533	V	Peak	58.99	± 4.00
		RMS	53.72	± 4.00
2.48351	V	Peak	62.50	± 4.00
		RMS	44.94	± 4.00
2.48643	V	Peak	59.98	± 4.00
		RMS	49.53	± 4.00
2.55539	V	Peak	58.78	± 4.00
		RMS	48.84	± 4.00
4.96025	H	Peak	40.19	± 4.00
7.44075	H	Peak	49.25	± 4.00
9.92025	H	Peak	48.05	± 4.00

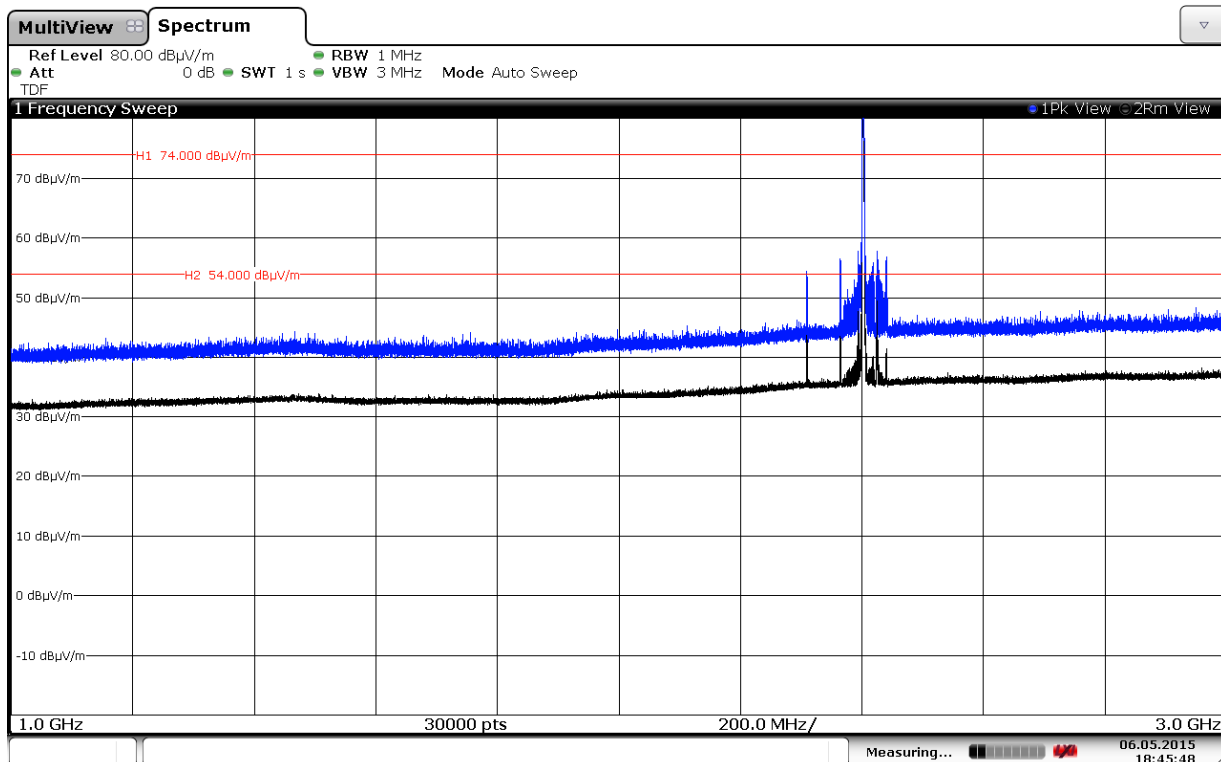
Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.



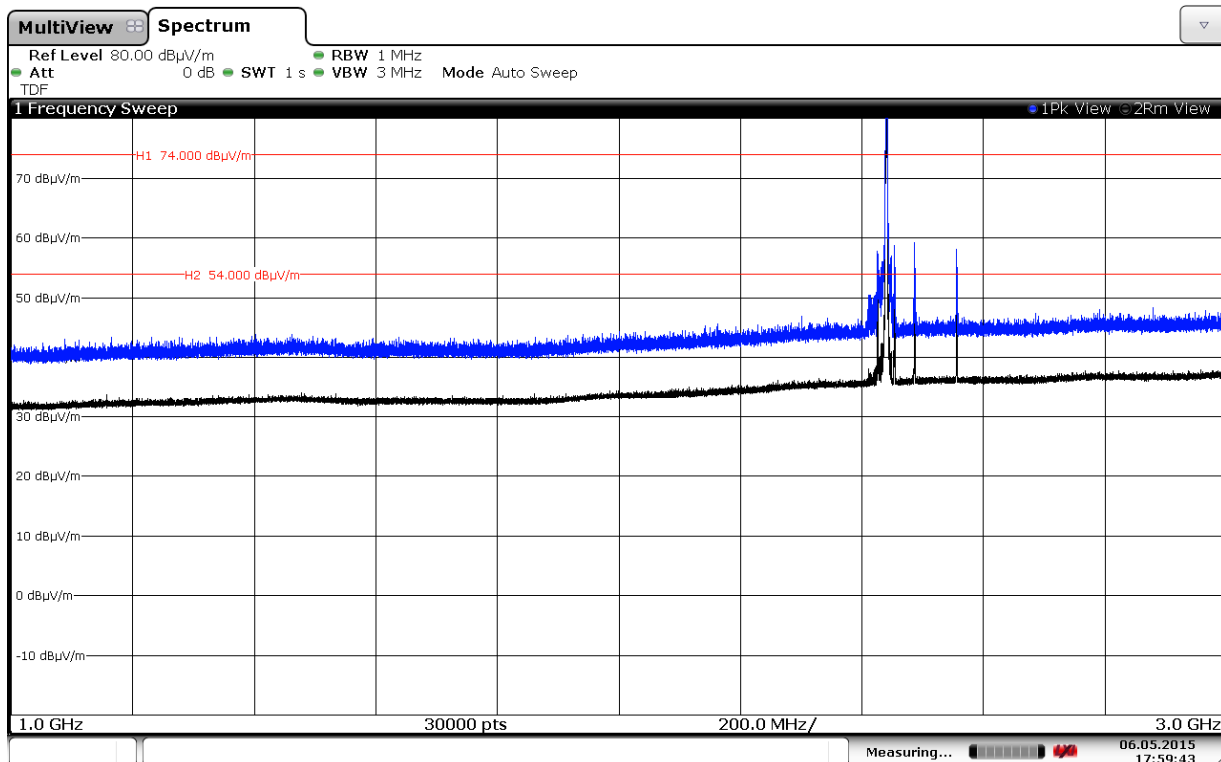
(This plot is valid for all three channels).

FREQUENCY RANGE 1 GHz to 3 GHz.
CHANNEL: Lowest (2402 MHz).



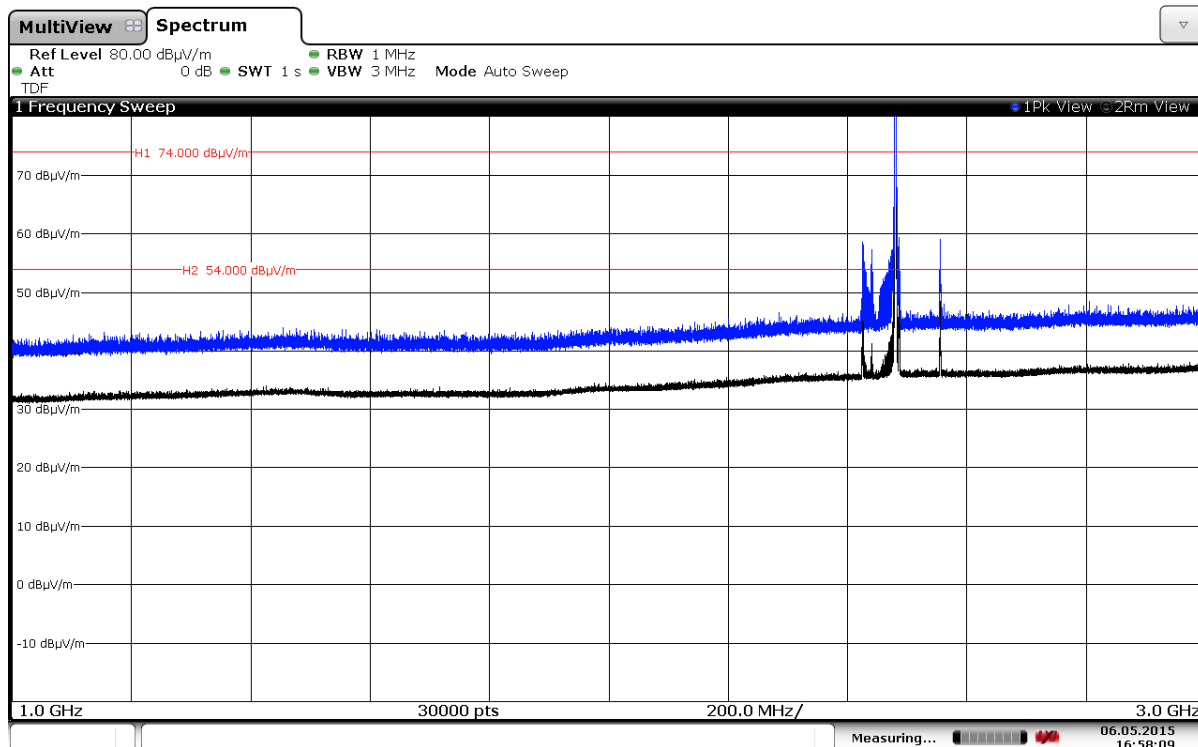
Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Middle (2440 MHz).



Note: The peak shown in the plot above the limit is the carrier frequency.

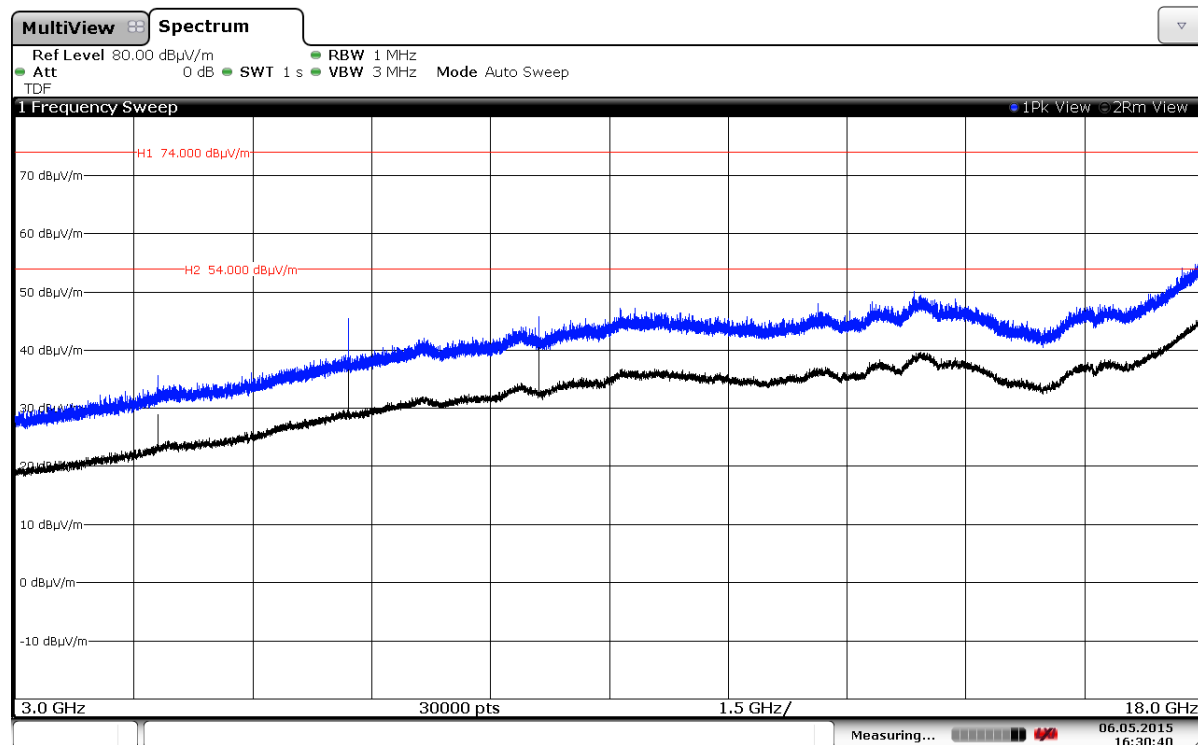
CHANNEL: Highest (2480 MHz).



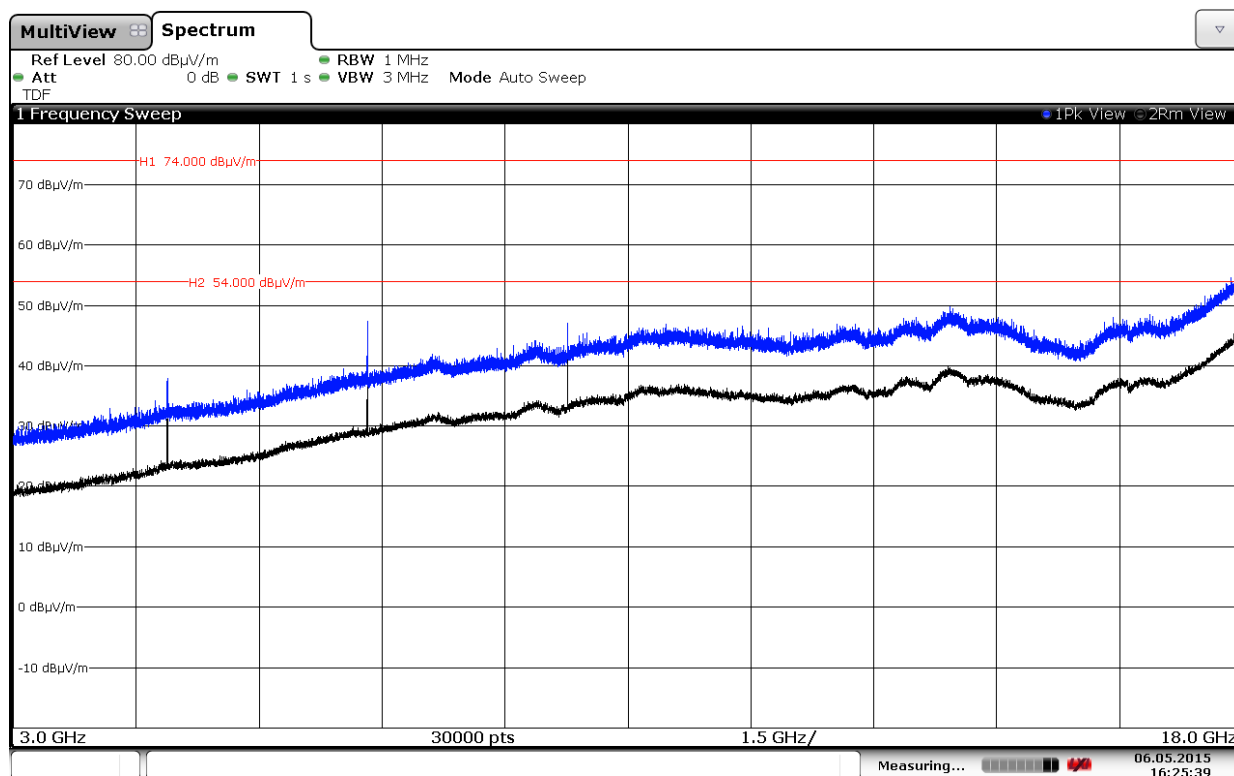
Note: The peak shown in the plot above the limit is the carrier frequency.

FREQUENCY RANGE 3 GHz to 18 GHz.

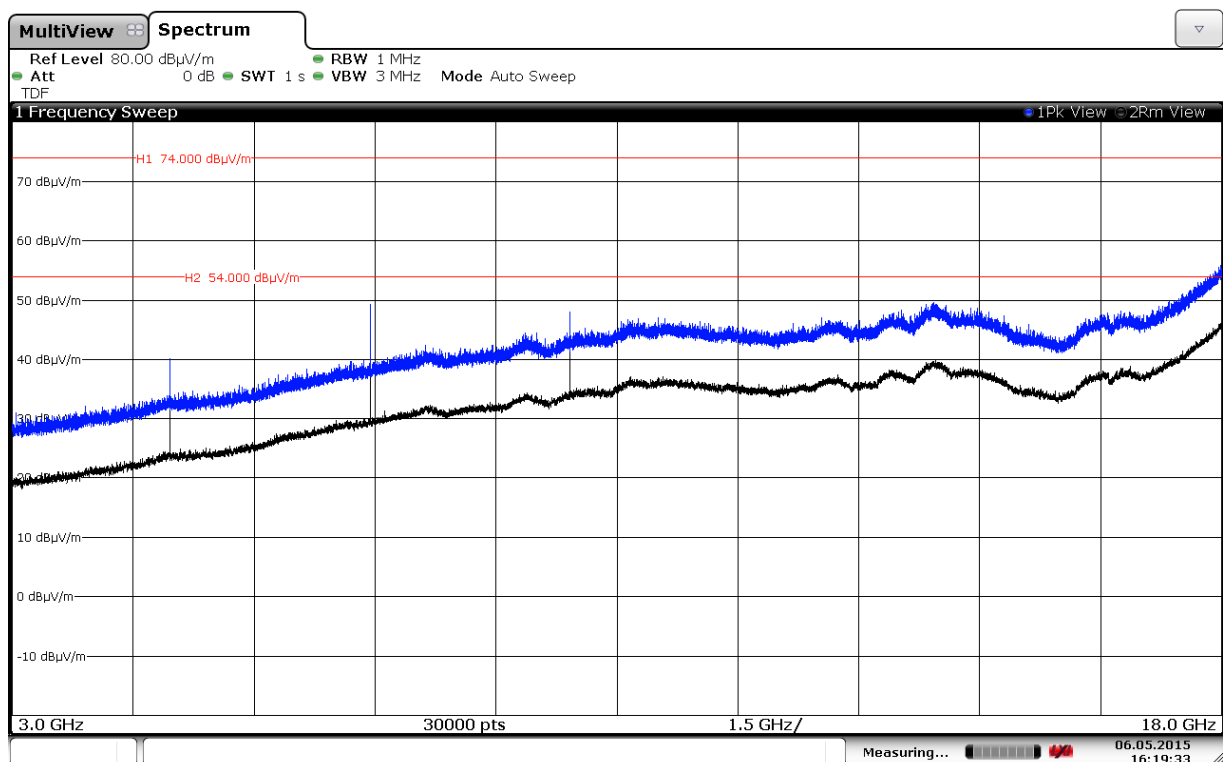
CHANNEL: Lowest (2402 MHz).



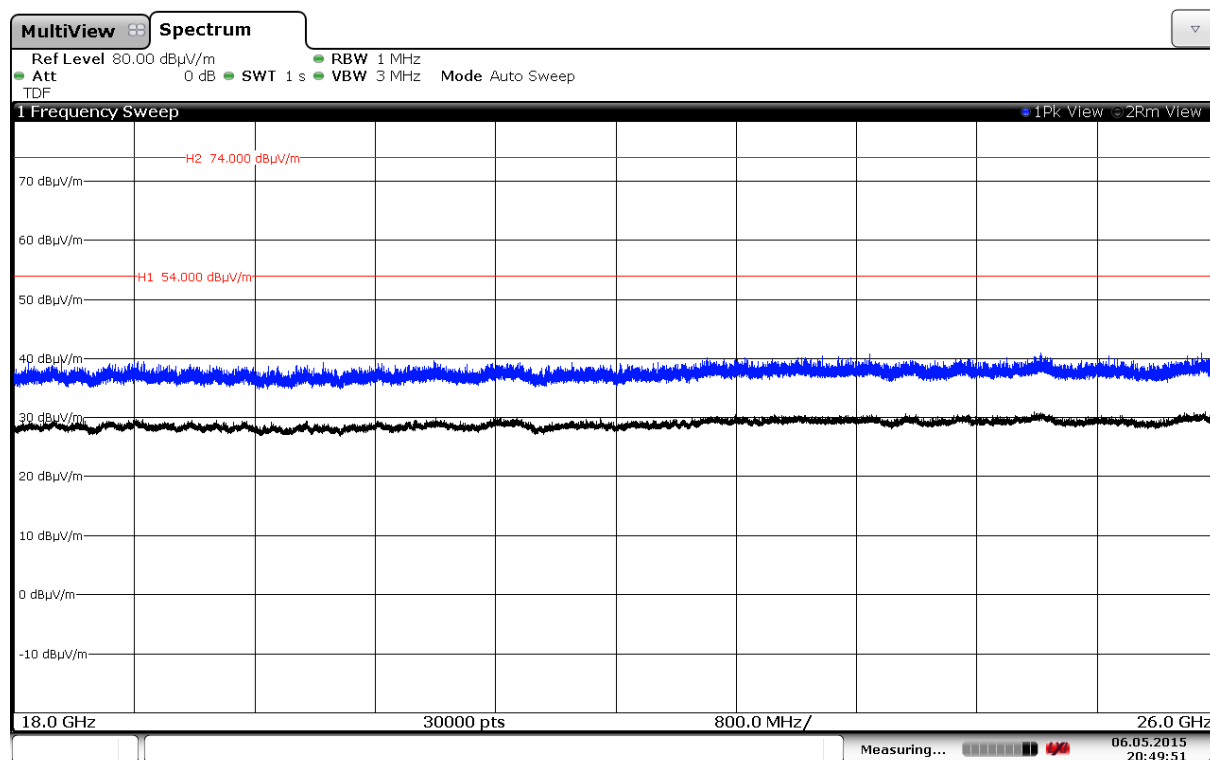
CHANNEL: Middle (2440 MHz).



CHANNEL: Highest (2480 MHz).



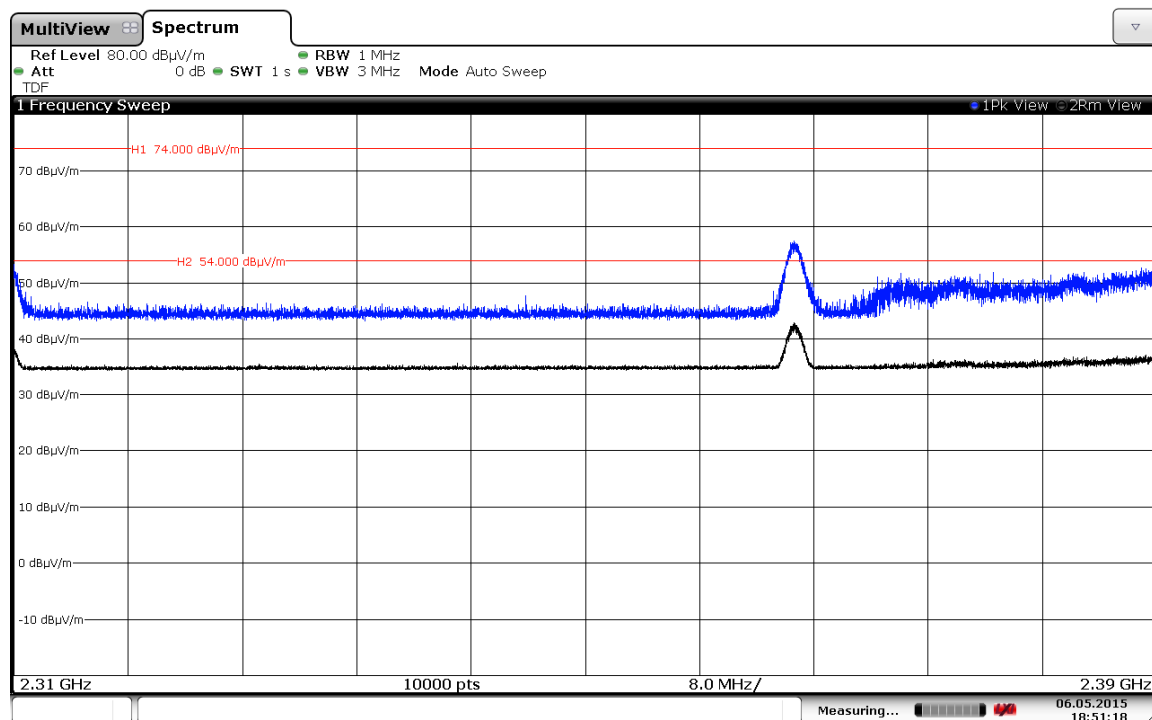
FREQUENCY RANGE 18 GHz to 26 GHz.



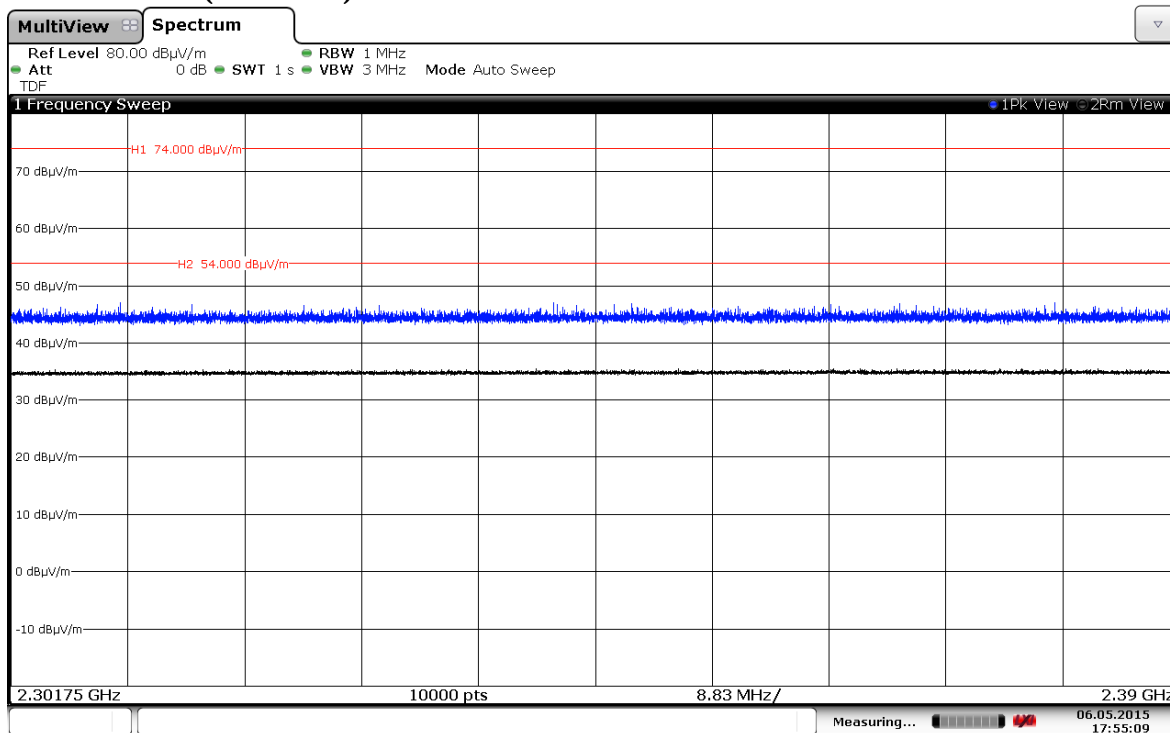
(This plot is valid for all three channels).

FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

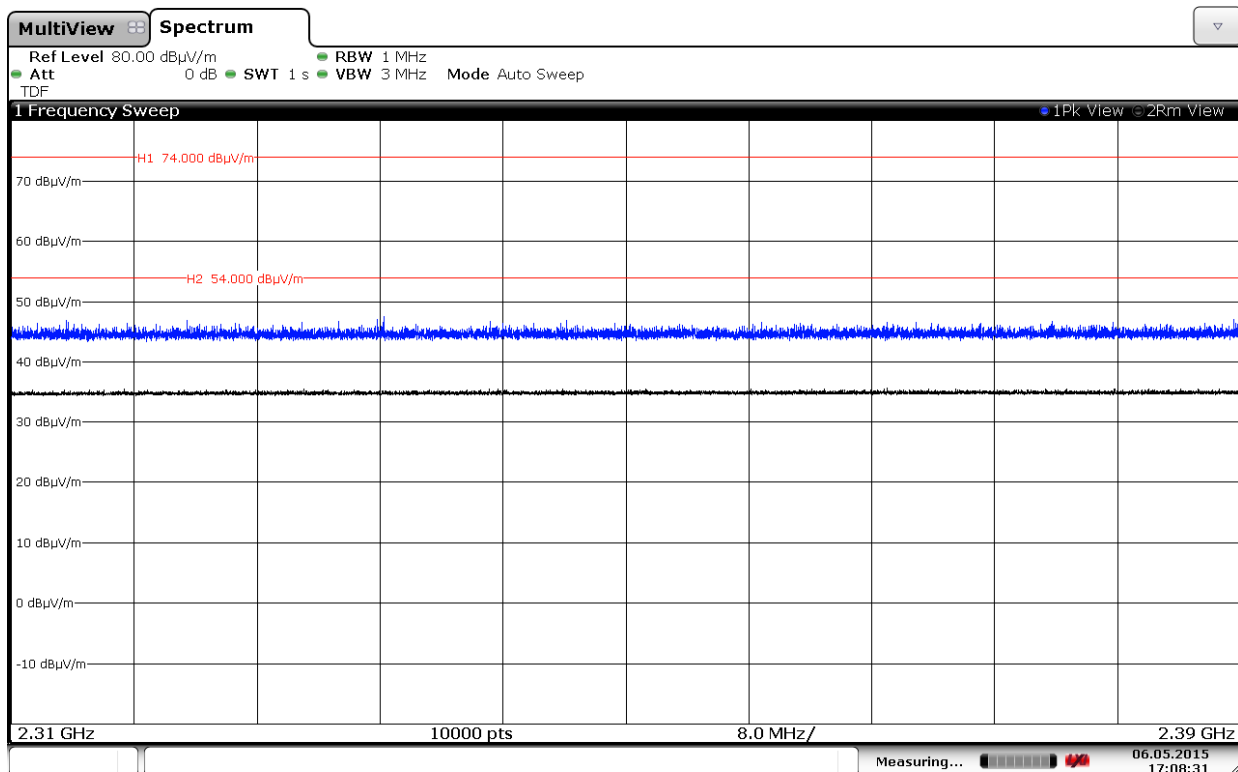
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2440 MHz).

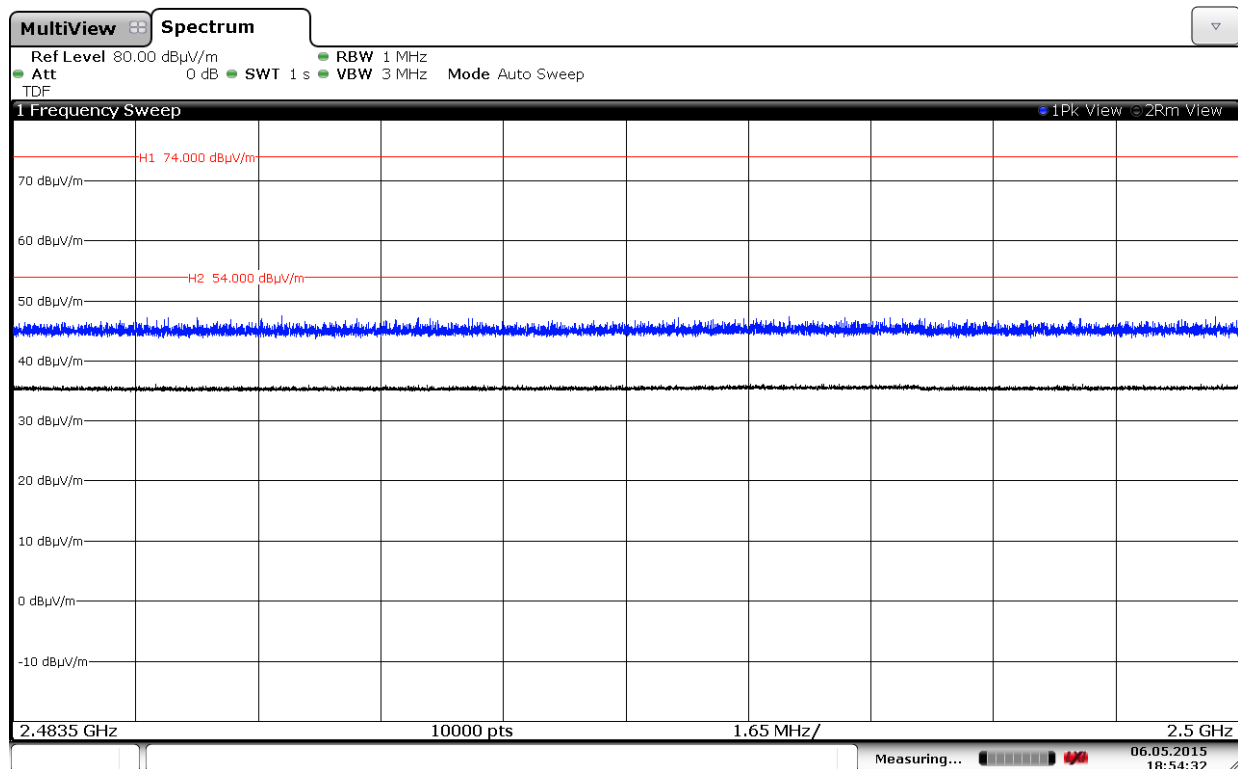


CHANNEL: Highest (2480 MHz).

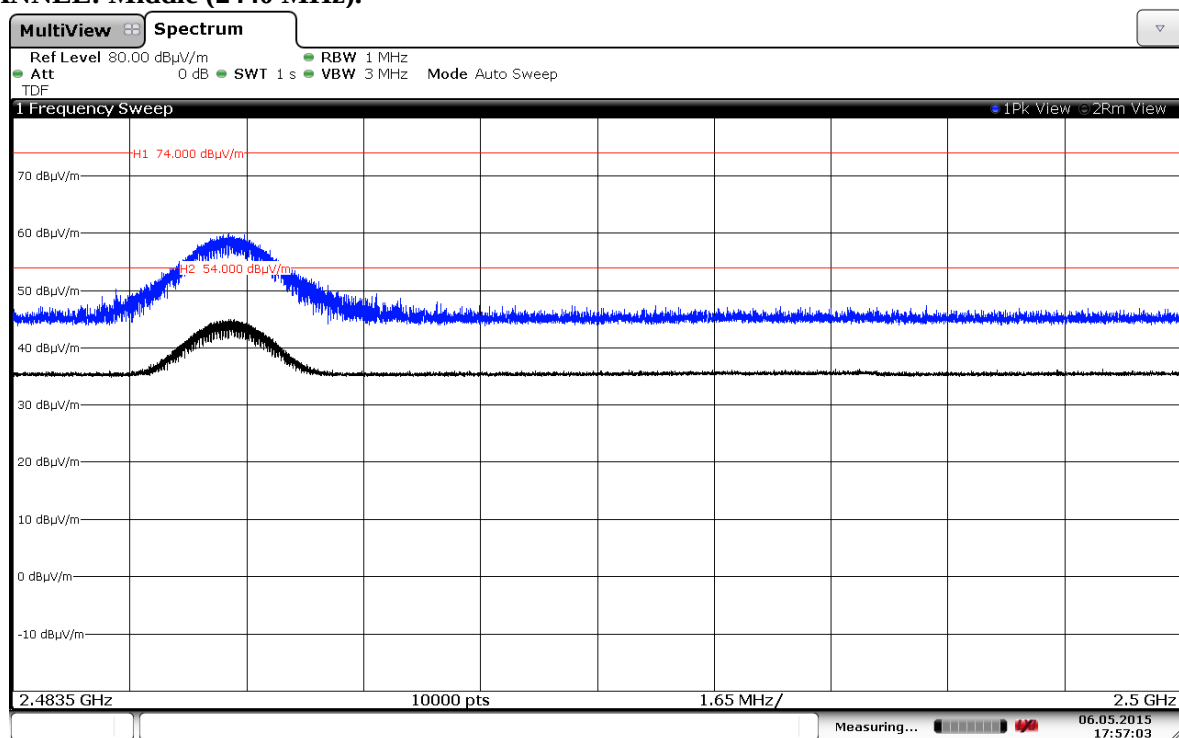


FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

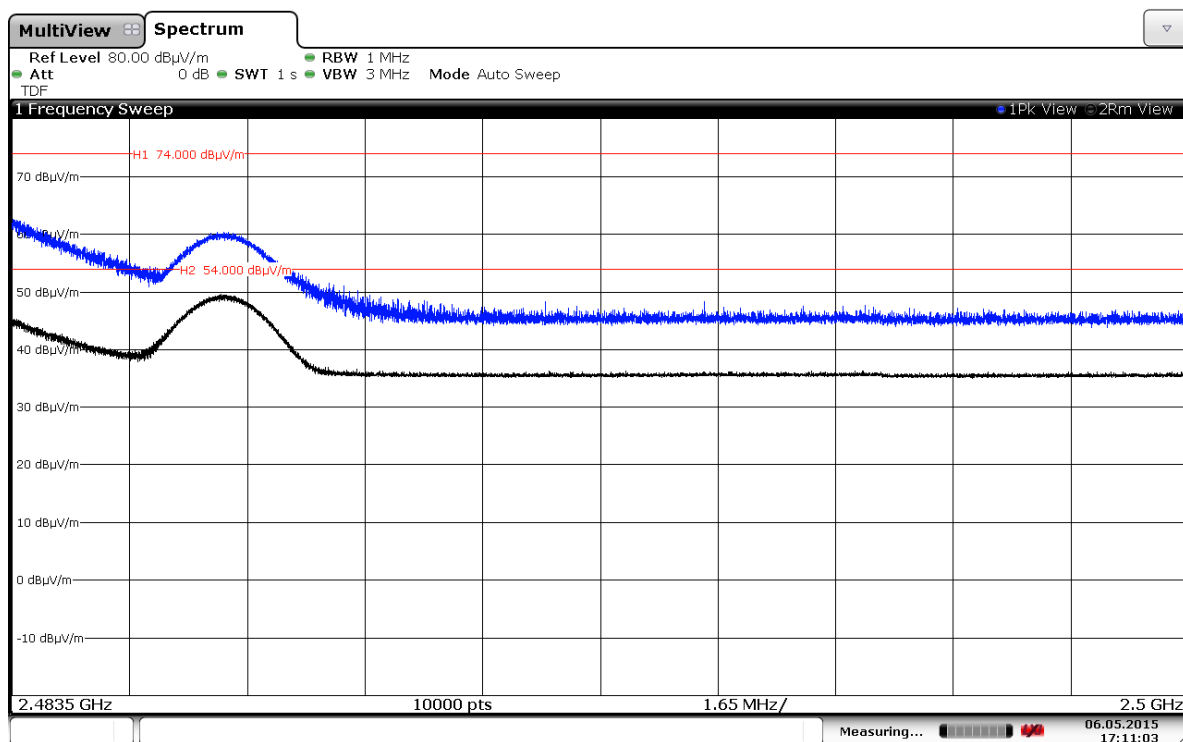
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2440 MHz).



CHANNEL: Highest (2480 MHz).



Appendix B – Measuring results for electromagnetic conducted emission

CONTENT

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CONTINUOUS CONDUCTED EMISSION ON POWER LEADS	41

DESCRIPTION OF THE OPERATION MODES

The operation modes used by the samples to which the present report refers, are shown in the following table:

OPERATION MODE	DESCRIPTION
OM#02	EUT ON. Charging batteries. Powered by USB. Bluetooth in transmission mode (Paired with H6 device). Receiving GPS signal.

CONTINUOUS CONDUCTED EMISSION ON POWER LEADS

Product standard :	FCC RULES AND REGULATIONS 47 CFR PART 15, SUBPART B (10-01-14 Edition) & ANSI C63.4-2009
Test standard :	FCC RULES AND REGULATIONS 47 CFR PART 15, SUBPART B (10-01-14 Edition) & ANSI C63.4-2009

CLASS B

The applied limit for continuous conducted emissions in power leads, according with the requirements of FCC Rules and Regulations 47 CFR Part 15, Subpart B (10-01-14 Edition) & ANSI C63.4-2009, in the frequency range 0,15 to 30 MHz, for Class B equipment was:

Frequency range (MHz)	Limit (dBμV)	
	Quasi-peak	Average
0,15 to 0,5	66-56	56-46
0,5 to 5	56	46
5 to 30	60	50

TESTED SAMPLES:	S/01
TESTED OPERATION MODES:	OM# 02
TEST RESULTS :	CCmmnnhh: CC, Conducted Condition; mm: Sample number; nn: Operation mode; hh: wire

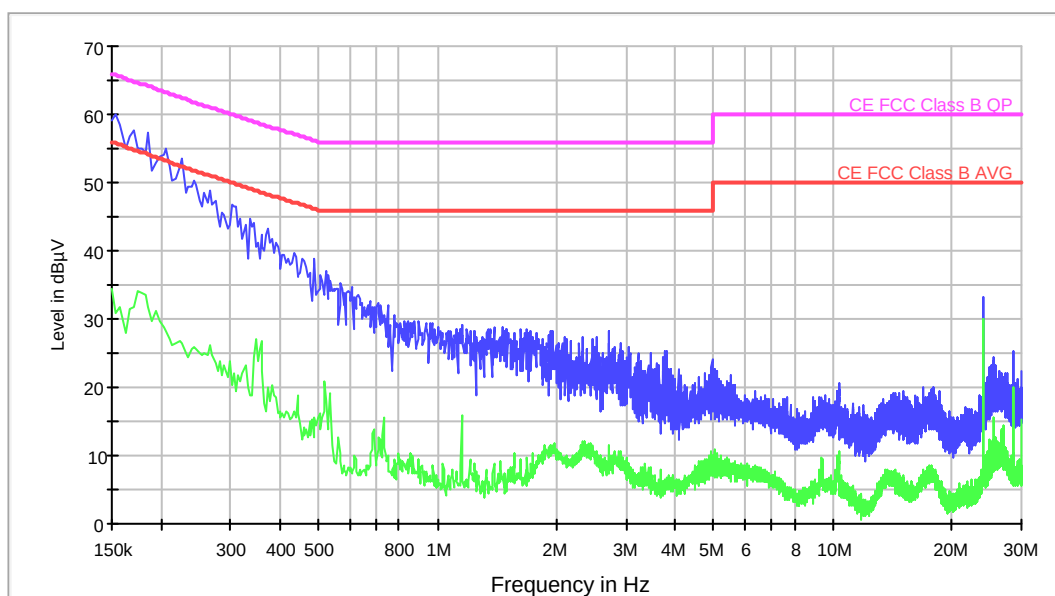
CCmmnnhh	Description	Result
CC01020N	Neutral wire noise	P
CC0102L1	Phase wire noise	P

Continuous Conducted Emission : CC01020N

Detector : Peak / Average / Cuasi-peak

Project: 46165REM.002
Company: POLAR
Sample: S/01
Operation mode: OM#02
Description: EUT ON. Charging batteries. Powered by USB. Bluetooth in transmission mode (Paired with H6 device). Receiving GPS signal. Neutral wire noise.

EC FCC Class B ESPI CC



— Peak Scan — Average Scan — CE FCC Class B AVG — CE FCC Class B QP

Subrange Maxima

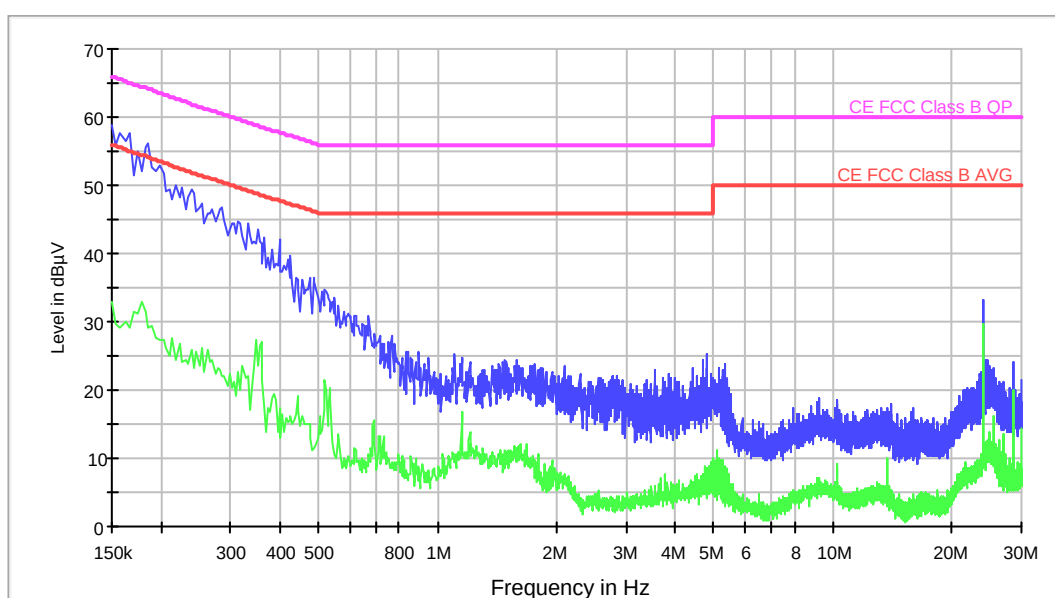
Frequency (MHz)	MaxPeak-ClearWrite (dBµV)	Average-ClearWrite (dBµV)
0.154000	60.0	30.8
0.266000	48.7	26.1
0.434000	39.6	16.6
0.750000	32.0	9.9
1.462000	28.8	6.4
2.722000	28.2	11.4
3.810000	25.3	6.3
10.338000	20.7	9.6
16.958000	19.9	6.7
24.002000	33.3	29.9

Continuous Conducted Emission : CC0102L1

Detector : Peak / Average / Cuasi-peak

Project: 46165REM.002
 Company: POLAR
 Sample: S/01
 Operation mode: OM#02
 Description: EUT ON. Charging batteries. Powered by USB. Bluetooth in transmission mode (Paired with H6 device). Receiving GPS signal. Phase wire noise.

EC FCC Class B ESPI CC



— Peak Scan — Average Scan — CE FCC Class B AVG — CE FCC Class B QP

Subrange Maxima

Frequency (MHz)	MaxPeak-ClearWrite (dBµV)	Average-ClearWrite (dBµV)
0.150000	58.7	33.1
0.286000	46.9	22.2
0.486000	36.5	11.6
0.766000	27.9	9.4
1.486000	24.5	11.1
3.542000	22.9	4.4
4.782000	25.3	5.4
9.226000	18.9	6.4
14.082000	17.9	5.0
24.002000	33.3	29.6