

ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER

Test Report No. : OT-18D-RWD-034
AGR No. : A18NA-180
Applicant : CAMMSYS Corp.
Address : 26, Venture-ro, 100beon-gil, Yeonsu-gu, Incheon, 22013, Korea
Manufacturer : CAMMSYS Corp.
Address : 26, Venture-ro, 100beon-gil, Yeonsu-gu, Incheon, 22013, Korea
Type of Equipment : BlackBox
FCC ID. : 2ARTT-CH300
Model Name : CH-300
Multiple Model Name : N/A
Serial number : N/A
Total page of Report : 38 pages (including this page)
Date of Incoming : October 19, 2018
Date of issue : December 21, 2018

SUMMARY

The equipment complies with the regulation; **FCC PART 15 SUBPART C Section 15.247**

This test report only contains the result of a single test of the sample supplied for the examination.

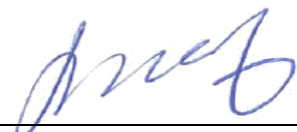
It is not a generally valid assessment of the features of the respective products of the mass-production.

Reviewed by:



Jae-Ho Lee / Chief Engineer
ONETECH Corp.

Approved by:



Keun-Young, Choi / Vice President
ONETECH Corp.

CONTENTS

PAGE

1. VERIFICATION OF COMPLIANCE	5
2. TEST SUMMARY	6
2.1 TEST ITEMS AND RESULTS	6
2.2 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS.....	6
2.3 RELATED SUBMITTAL(S) / GRANT(S)	6
2.4 PURPOSE OF THE TEST	6
2.5 TEST METHODOLOGY.....	6
2.6 TEST FACILITY.....	6
3. GENERAL INFORMATION.....	7
3.1 PRODUCT DESCRIPTION.....	7
3.2 ALTERNATIVE TYPE(S)/MODEL(S); ALSO COVERED BY THIS TEST REPORT.....	7
4. EUT MODIFICATIONS.....	7
5. SYSTEM TEST CONFIGURATION	8
5.1 JUSTIFICATION.....	8
5.2 PERIPHERAL EQUIPMENT	8
5.3 MODE OF OPERATION DURING THE TEST	8
5.4 CONFIGURATION OF TEST SYSTEM.....	9
5.5 ANTENNA REQUIREMENT	9
6. PRELIMINARY TEST	9
6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS.....	9
6.2 GENERAL RADIATED EMISSIONS TESTS	9
7. MIMIMUM 6 DB BANDWIDTH	10
7.1 OPERATING ENVIRONMENT	10
7.2 TEST SET-UP	10
7.3 TEST EQUIPMENT USED	10
7.4 TEST DATA FOR DC 12 V	11
7.5 TEST DATA FOR DC 24 V	13
8. MAXIMUM PEAK OUTPUT POWER.....	15
8.1 OPERATING ENVIRONMENT	15
8.2 TEST SET-UP	15
8.3 TEST EQUIPMENT USED	15
8.4 TEST DATA FOR 12 V	16

8.5 TEST DATA FOR 24 V	18
9. 100 KHZ BANDWIDTH OUTSIDE THE FREQUENCY BAND.....	20
9.1 OPERATING ENVIRONMENT	20
9.2 TEST SET-UP FOR CONDUCTED MEASUREMENT	20
9.3 TEST SET-UP FOR RADIATED MEASUREMENT.....	20
9.4 TEST EQUIPMENT USED	20
9.5 TEST DATA FOR CONDUCTED EMISSION	21
9.6 TEST DATA FOR RADIATED EMISSION	26
9.6.1 Radiated Emission which fall in the Restricted Band (DC 12 V).....	26
9.6.2 Radiated Emission which fall in the Restricted Band (DC 24 V).....	27
9.6.3 Spurious & Harmonic Radiated Emission (DC 12 V)	28
9.6.4 Spurious & Harmonic Radiated Emission (DC 24 V)	29
10.1 OPERATING ENVIRONMENT	30
10.2 TEST SET-UP	30
10.3 TEST EQUIPMENT USED	30
10.4 TEST DATA FOR DC 12 V	31
10.5 TEST DATA FOR DC 24 V	33
11. RADIATED EMISSION TEST	35
11.1 OPERATING ENVIRONMENT	35
11.2 TEST SET-UP	35
11.3 TEST EQUIPMENT USED	35
11.4 TEST DATA FOR TRANSMITTING MODE	36
11.4.1 Test data for 30 MHz ~ 1 GHz (DC 12 V).....	36
11.4.2 Test data for 30 MHz ~ 1 GHz (DC 24 V).....	37
11.4.3 Test data for Below 30 MHz	38
11.4.4 Test data for above 1 GHz	38

Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-18D-RWD-034	December 21, 2018	Initial Issue	All

1. VERIFICATION OF COMPLIANCE

Applicant : CAMMSYS Corp.

Address : 26, Venture-ro, 100beon-gil, Yeonsu-gu, Incheon, 22013, Korea

Contact Person : Kyunghwan Na / Senior Manager

Telephone No. : +82-70-4680-2592

FCC ID : 2ARTT-CH300

Model Name : CH-300

Serial Number : N/A

Date : December 21, 2018

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
KIND OF EQUIPMENT	BlackBox
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m, Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (2)	Minimum 6 dB Bandwidth	Met the Limit / PASS
15.247 (b) (3)	Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.247 (e)	Peak Power Spectral Density	Met the Limit / PASS
15.209	Radiated Emission Limits	Met the Limit / PASS
15.207	Conducted Limits	N/A
15.203	Antenna Requirement	Met requirement / PASS

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247.

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-4112/ C-14617/ G-10666 / T-1842

IC (Industry Canada) – Registration No. Site# 3736A-3

-. Site Accreditation:

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The CAMMSYS Corp. , Model CH-300 (referred to as the EUT in this report) is a BlackBox. The product specification described herein was obtained from product data sheet or user's manual.

Device Type	BlackBox
Operating Frequency	2 422 MHz ~ 2 452 MHz
RF Output Power	16.91 dBm
Number of Channel	7 Channels
Modulation Type	OFDM
Antenna Type	PCB Pattern Antenna
Antenna Gain	-0.59 dBi
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	24 MHz
Rated Supply Voltage	DC 12.0 V, DC 24.0 V

3.2 Alternative type(s)/model(s); also covered by this test report.

-. None

4. EUT MODIFICATIONS

-. None

5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	N/A	N/A	-

5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
HP Pavilion g series	HP	Notebook PC	EUT
Series PPP009L-E	LIE-ON- TECHNOLOGY(CHANGZHOU)CO.,LTD	AC adapter	Notebook PC
DC Power Supply	Protek	PWS-3003D	EUT

5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting is programmed.

For final testing, the EUT was set at 2 422 MHz, 2 442 MHz, and 2 452 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XY” axis, but the worst data was recorded in this report.

5.4 Configuration of Test System

Radiated Emission Test: Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 meter Semi Anechoic Chamber.

The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

5.5 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The antenna of the EUT is a PCB Pattern Antenna on the main board in the EUT, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

As this product is only using DC power, AC conducted emission test has not been performed.

6.2 General Radiated Emissions Tests

During Preliminary Tests, the following operating modes were investigated

Operation Mode	The Worse operating condition (Please check one only)
Transmitting Mode	X

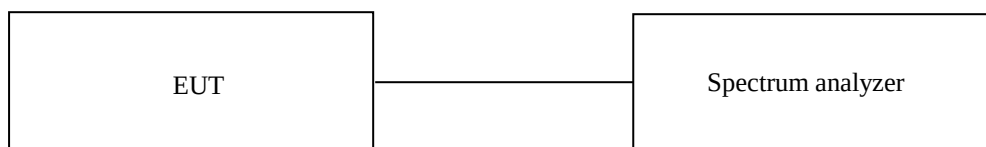
7. MINIMUM 6 dB BANDWIDTH

7.1 Operating environment

Temperature : 25 °C
Relative humidity : 46 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.



7.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug 23, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

7.4 Test data for DC 12 V

-. Test Date : October 22, 2018 ~ November 23, 2018

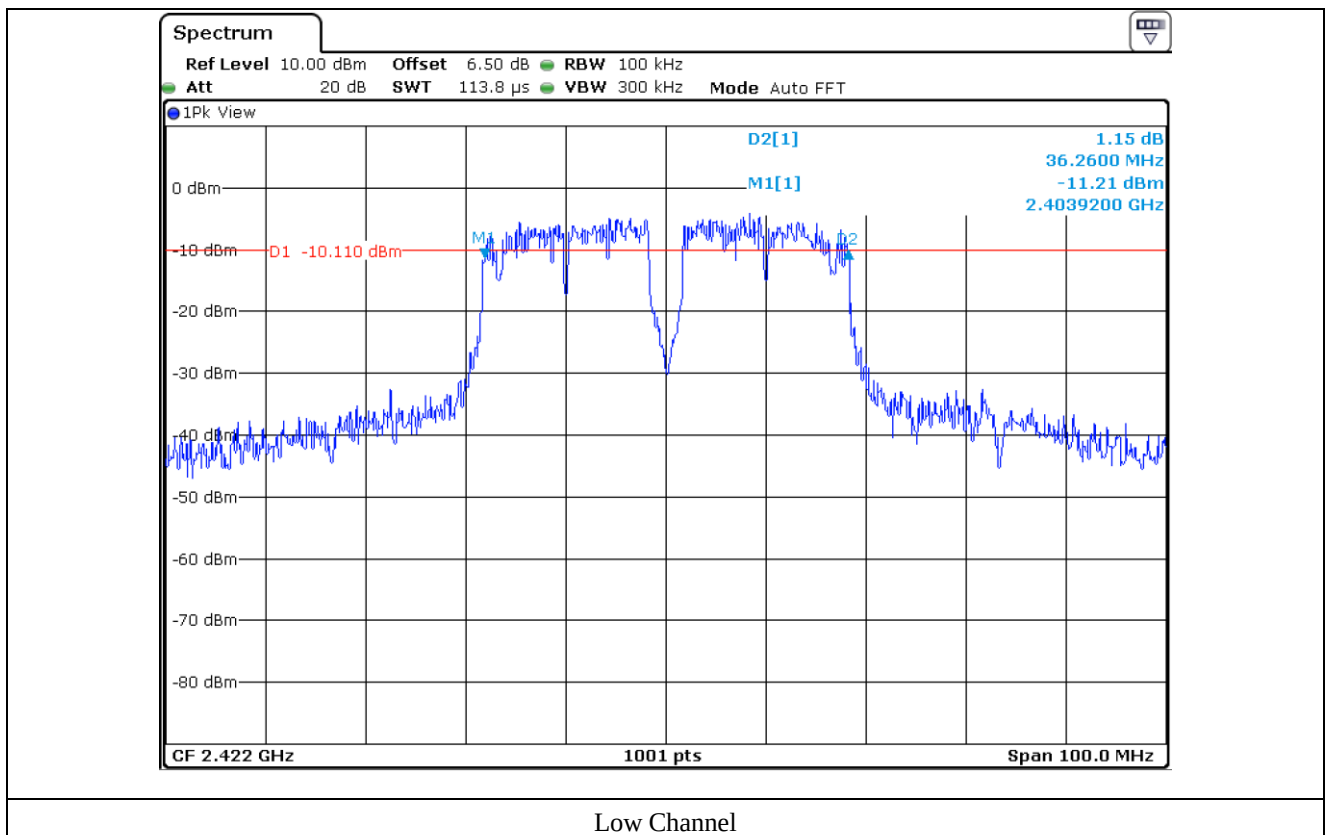
-. Test Result : Pass

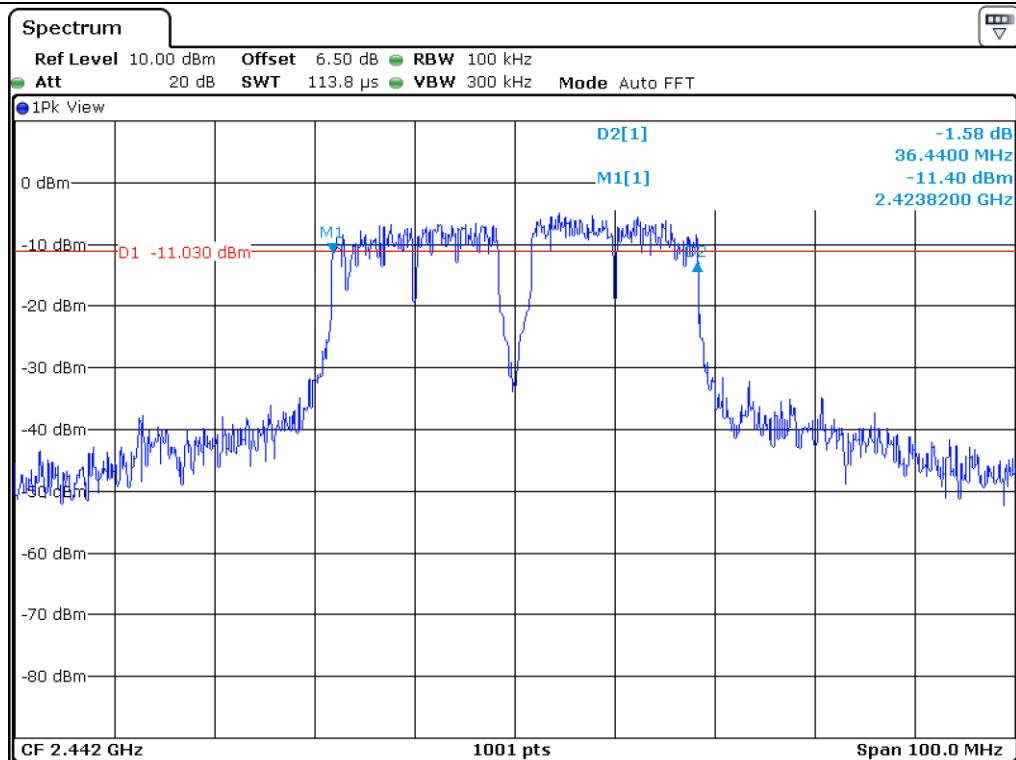
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (MHz)	LIMIT (kHz)
Low	2 422.00	36.26	≥ 500
Middle	2 442.00	36.44	≥ 500
High	2 452.00	36.43	≥ 500

Remark. Margin = Measured Value - Limit

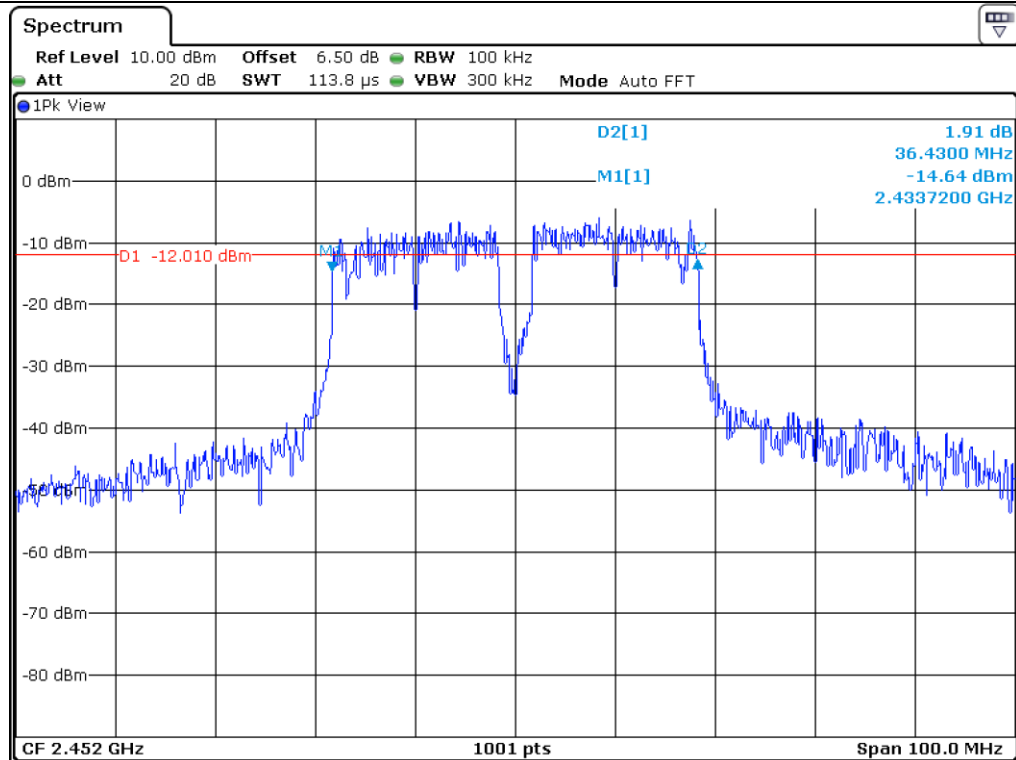


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

7.5 Test data for DC 24 V

-. Test Date : October 22, 2018 ~ November 23, 2018

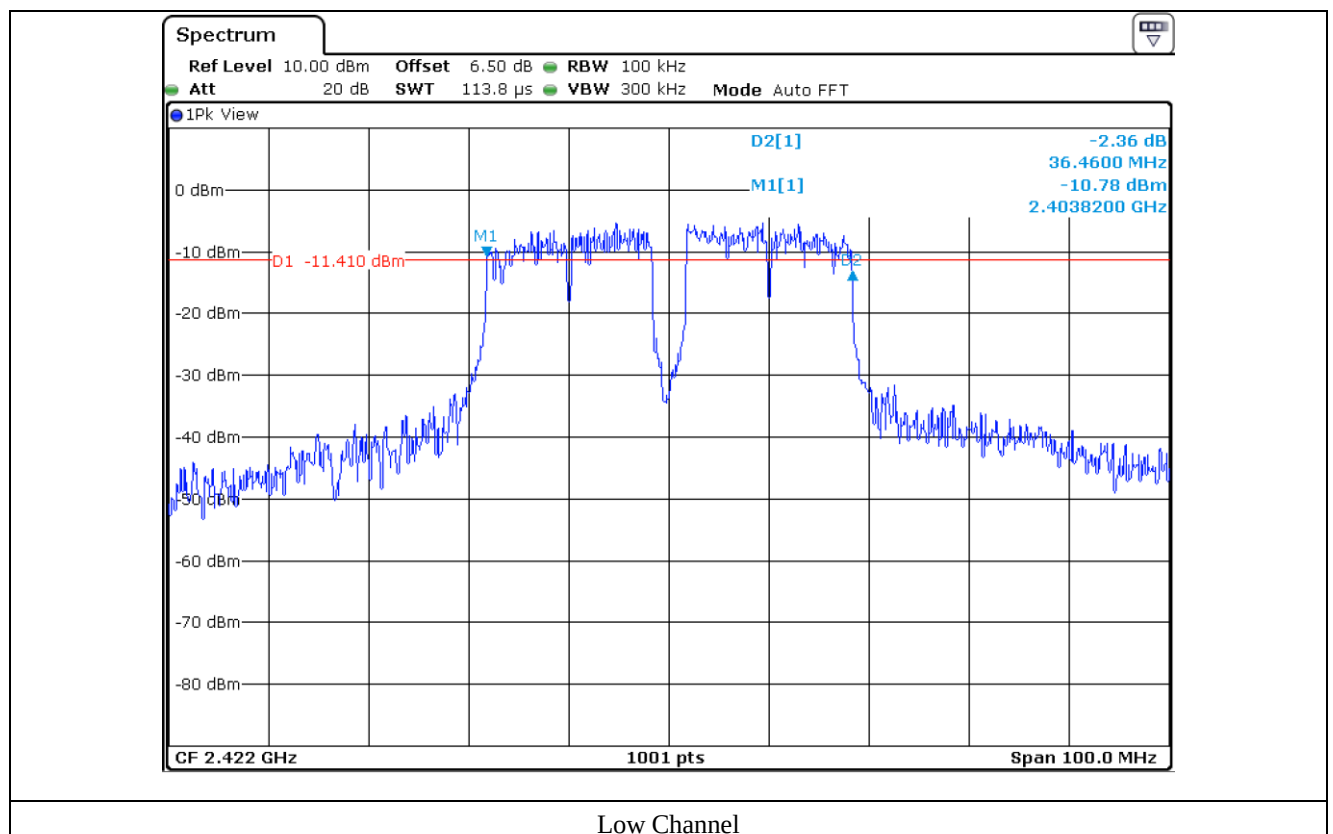
-. Test Result : Pass

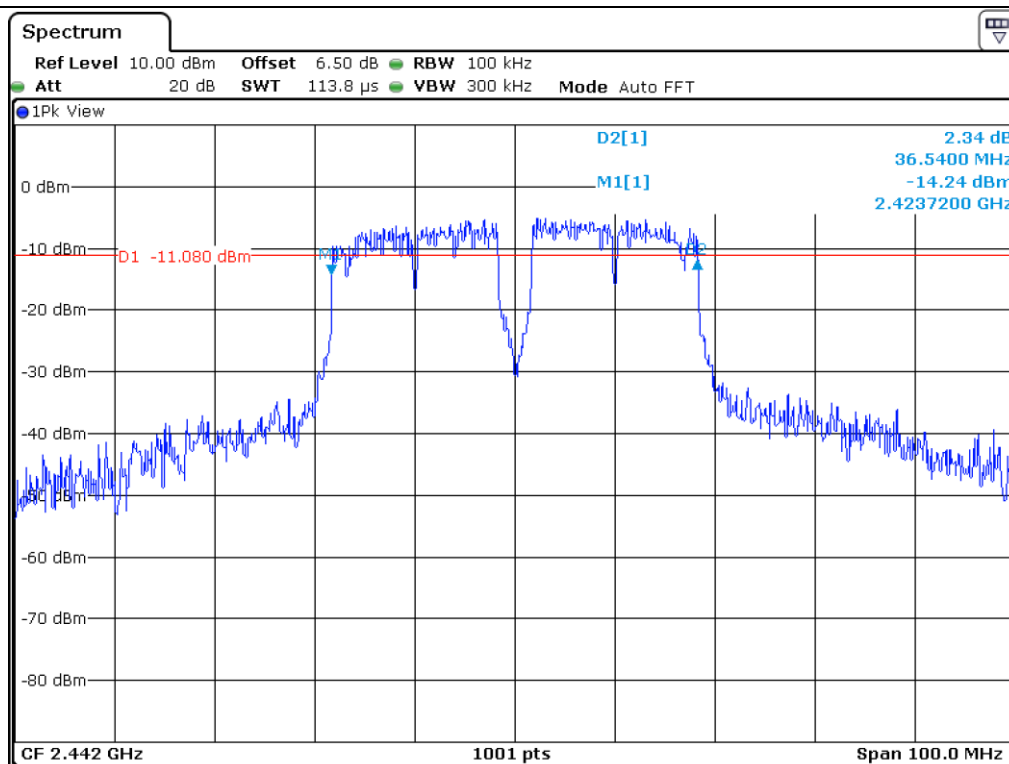
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (MHz)	LIMIT (kHz)
Low	2 422.00	36.46	≥ 500
Middle	2 442.00	36.54	≥ 500
High	2 452.00	35.53	≥ 500

Remark. Margin = Measured Value - Limit

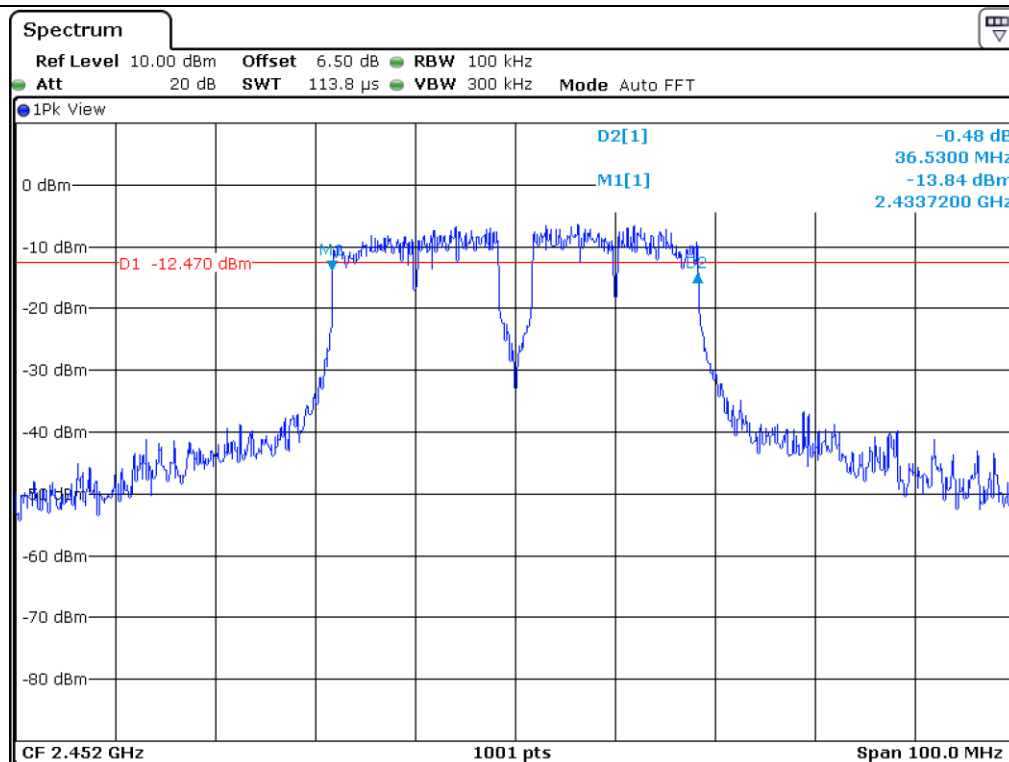


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

8. MAXIMUM PEAK OUTPUT POWER

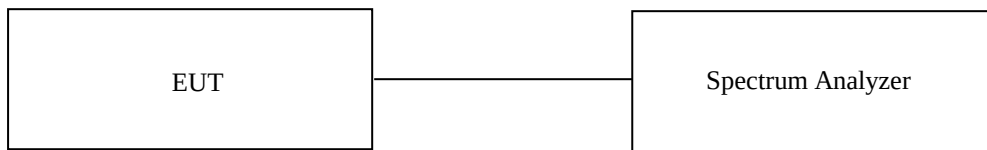
8.1 Operating environment

Temperature : 25 °C
Relative humidity : 46 % R.H.

8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to $\geq$ DTS Bandwidth, the video bandwidth is set to 3 times the resolution bandwidth.



8.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug 23, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

8.4 Test data for 12 V

-. Test Date : October 22, 2018 ~ November 23, 2018

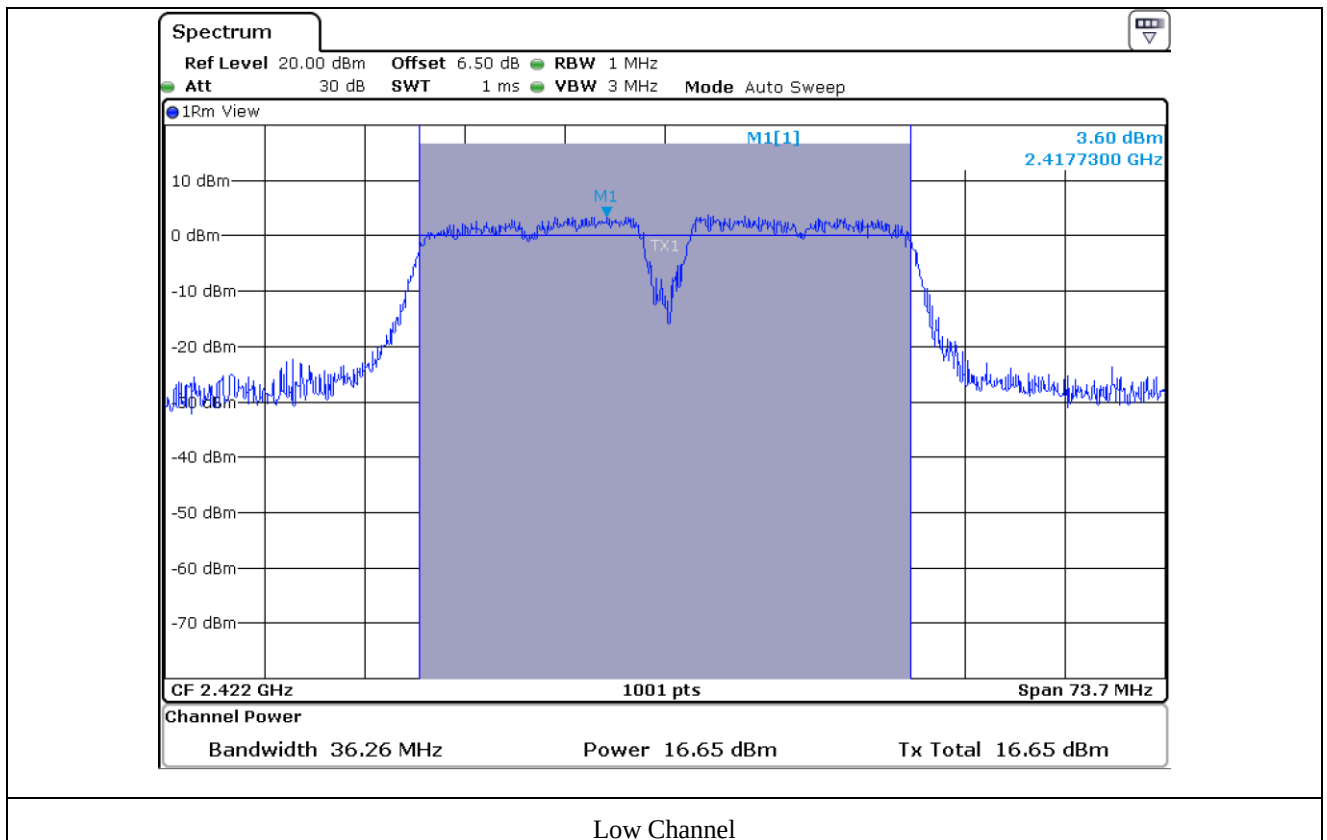
-. Test Result : Pass

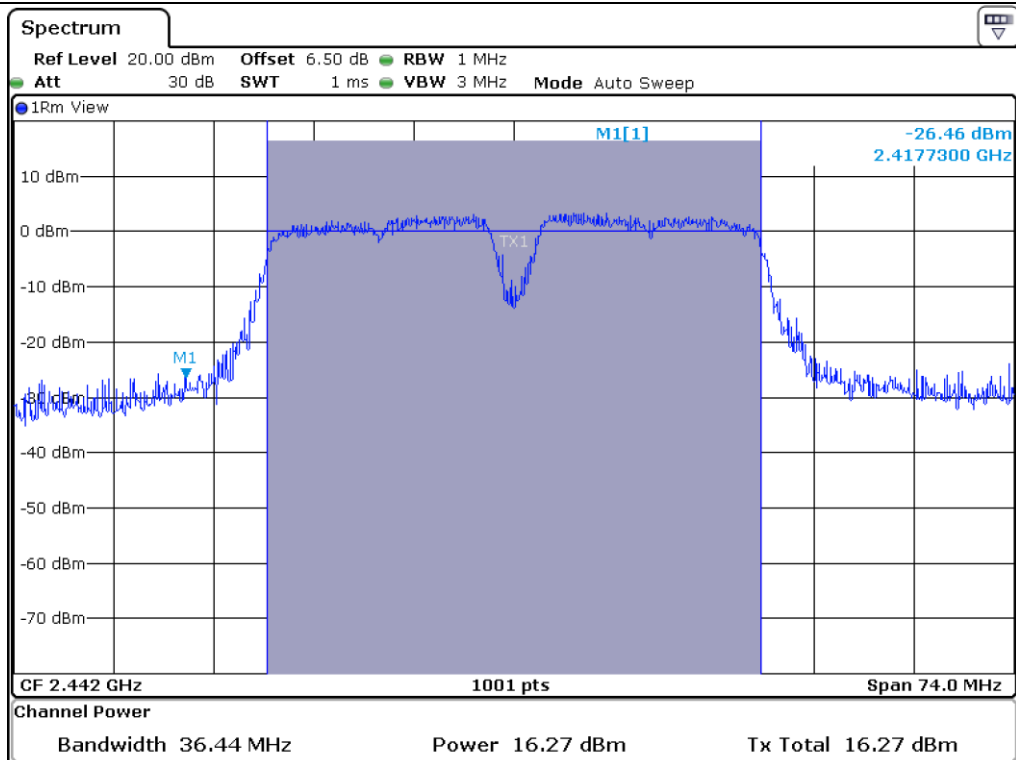
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 422.00	16.65	30.00	13.35
MIDDLE	2 442.00	16.27	30.00	13.73
HIGH	2 452.00	15.26	30.00	14.74

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

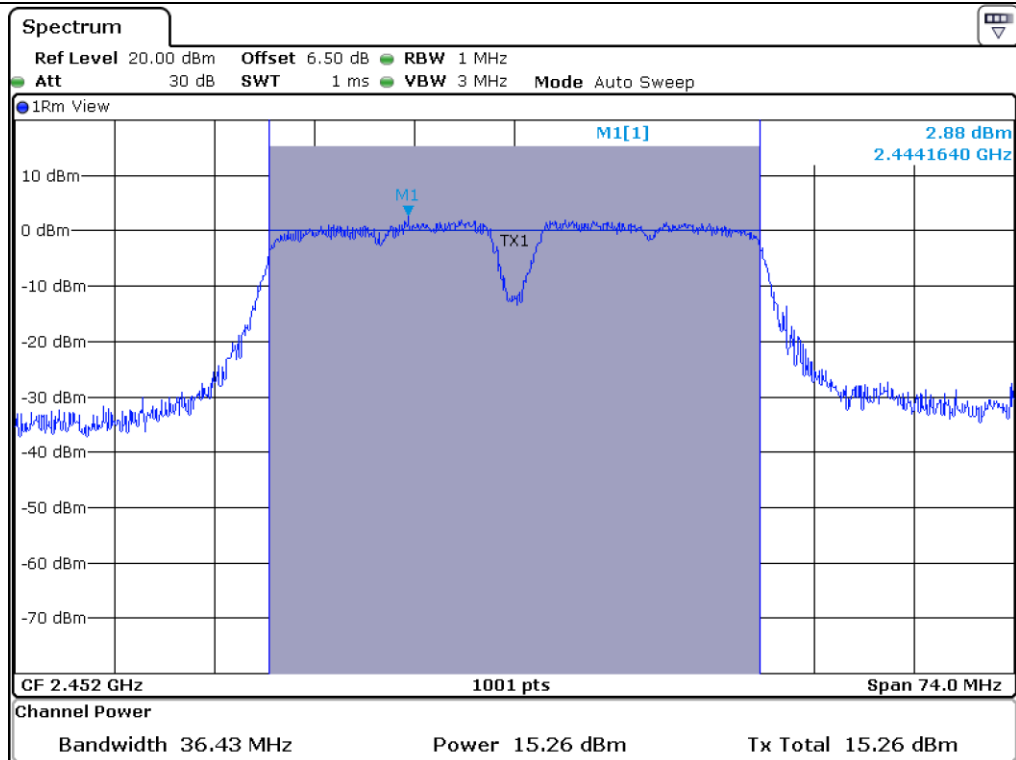


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

8.5 Test data for 24 V

-. Test Date : October 22, 2018 ~ November 23, 2018

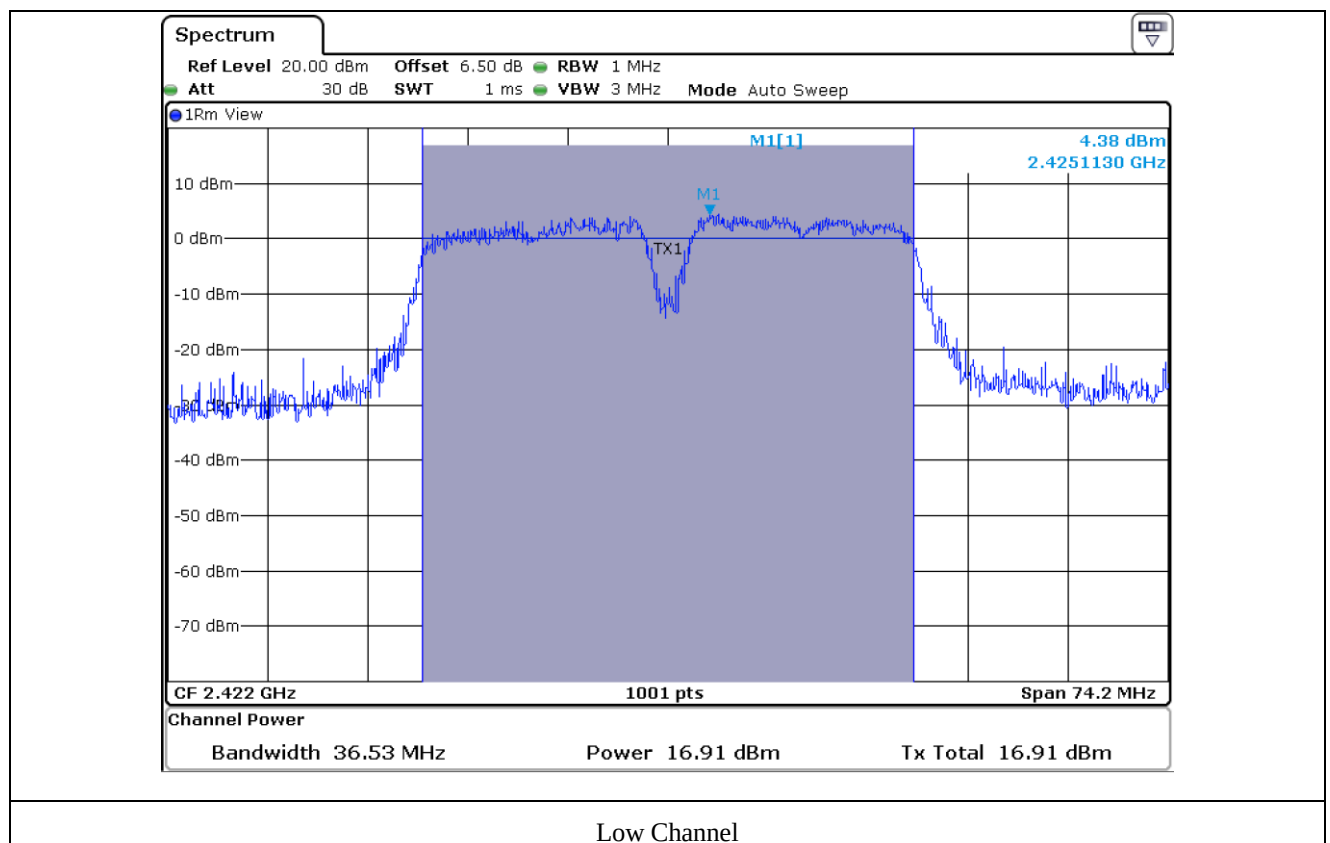
-. Test Result : Pass

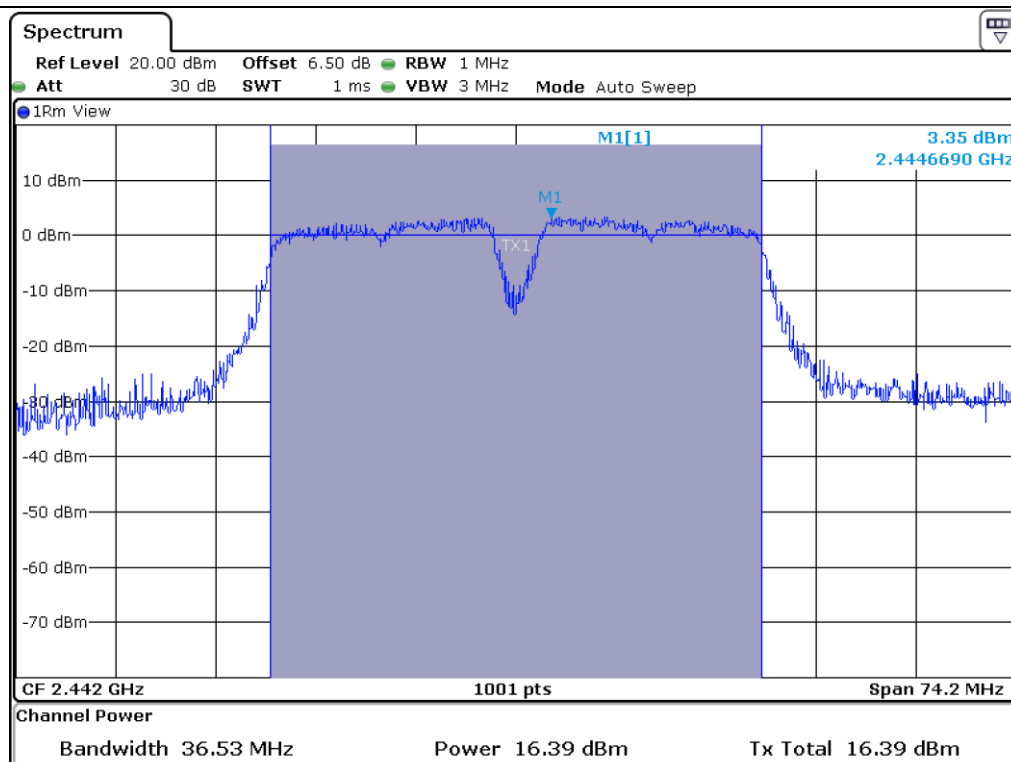
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 422.00	16.91	30.00	13.09
MIDDLE	2 442.00	16.39	30.00	13.61
HIGH	2 452.00	15.05	30.00	14.95

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

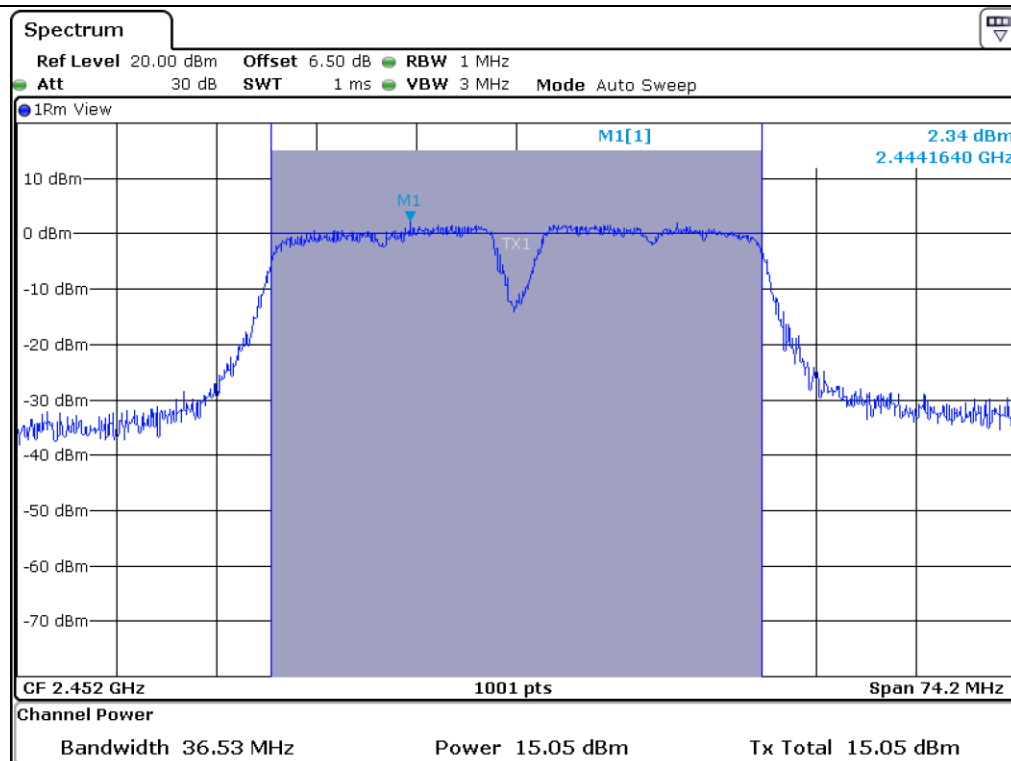


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

9.1 Operating environment

Temperature : 25 °C
Relative humidity : 46 % R.H.

9.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution and video bandwidth is set to 100 kHz, and peak detection was used.



9.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

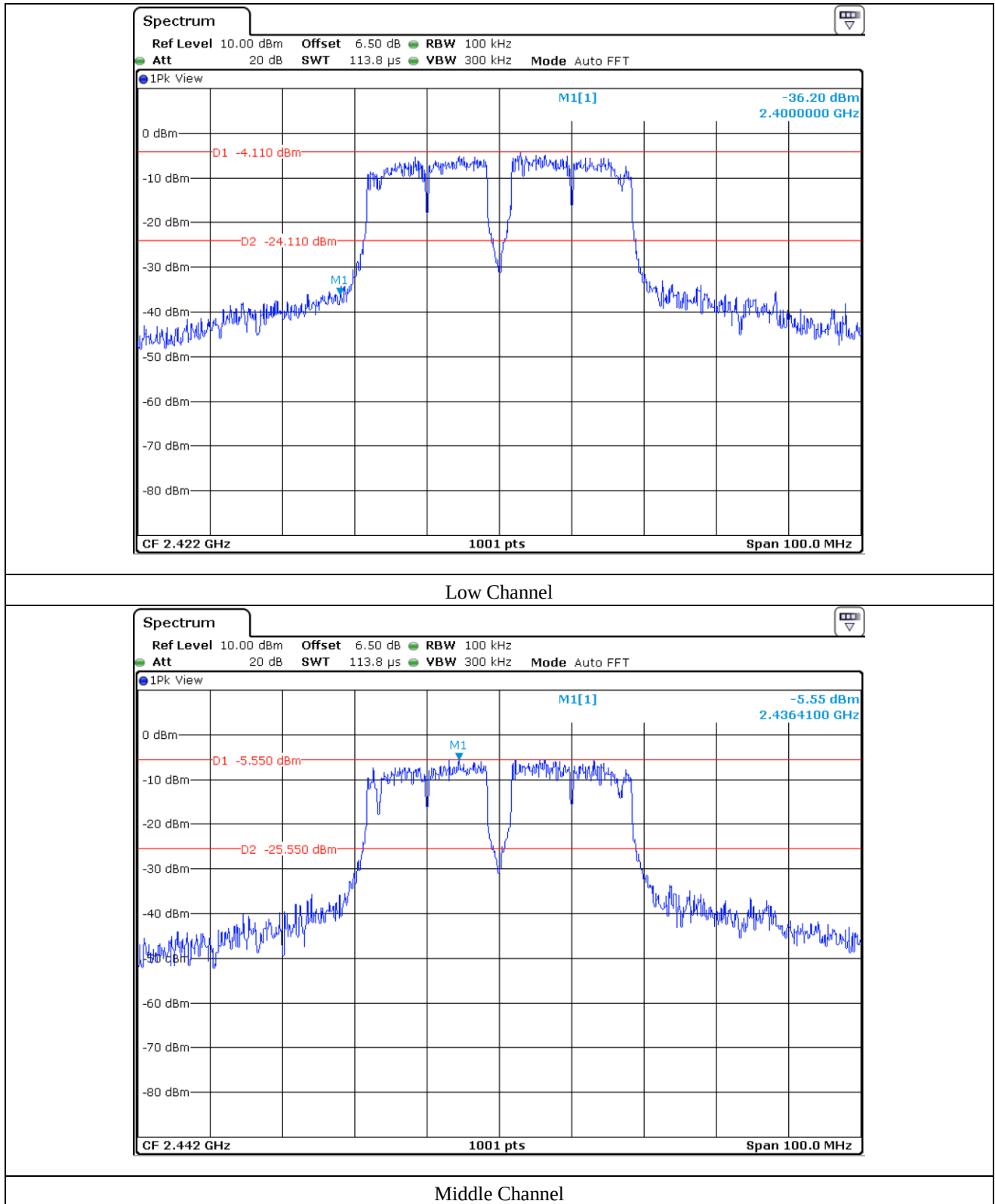
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

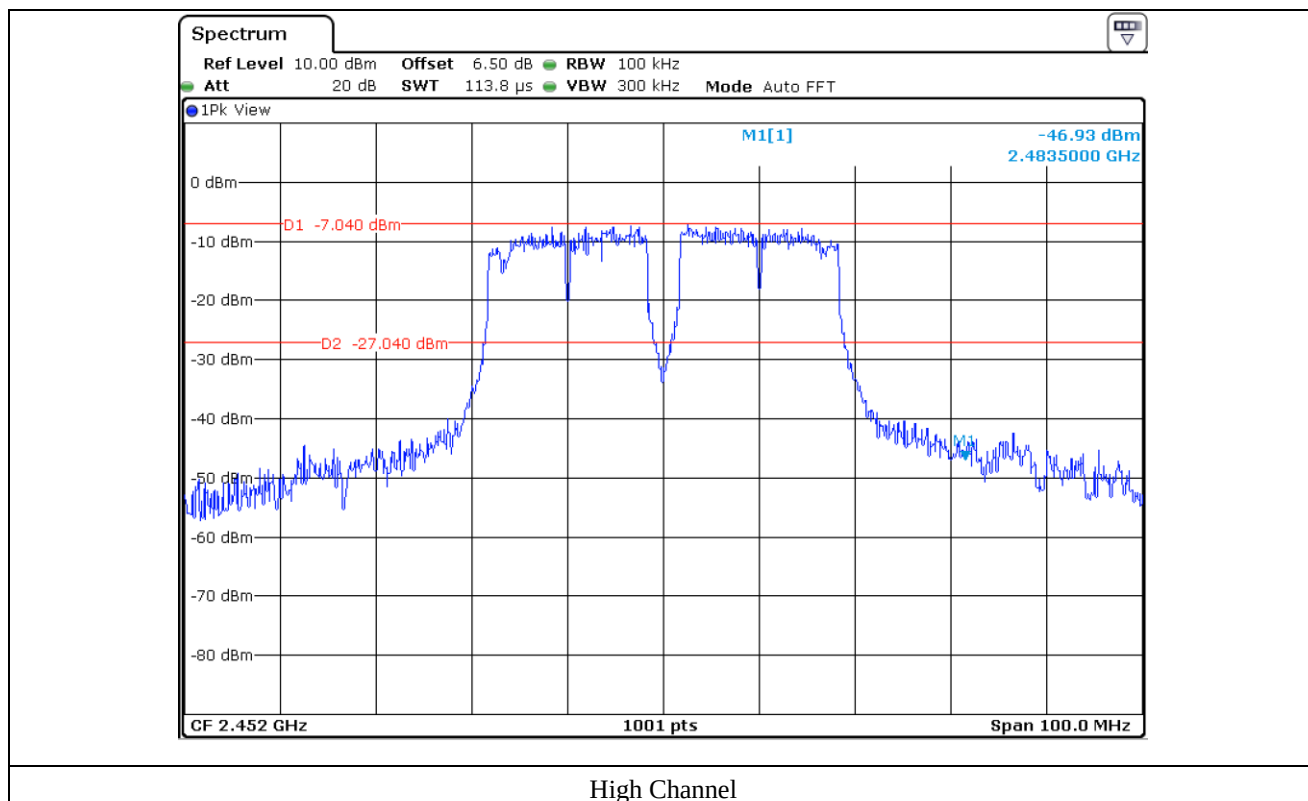
9.4 Test equipment used

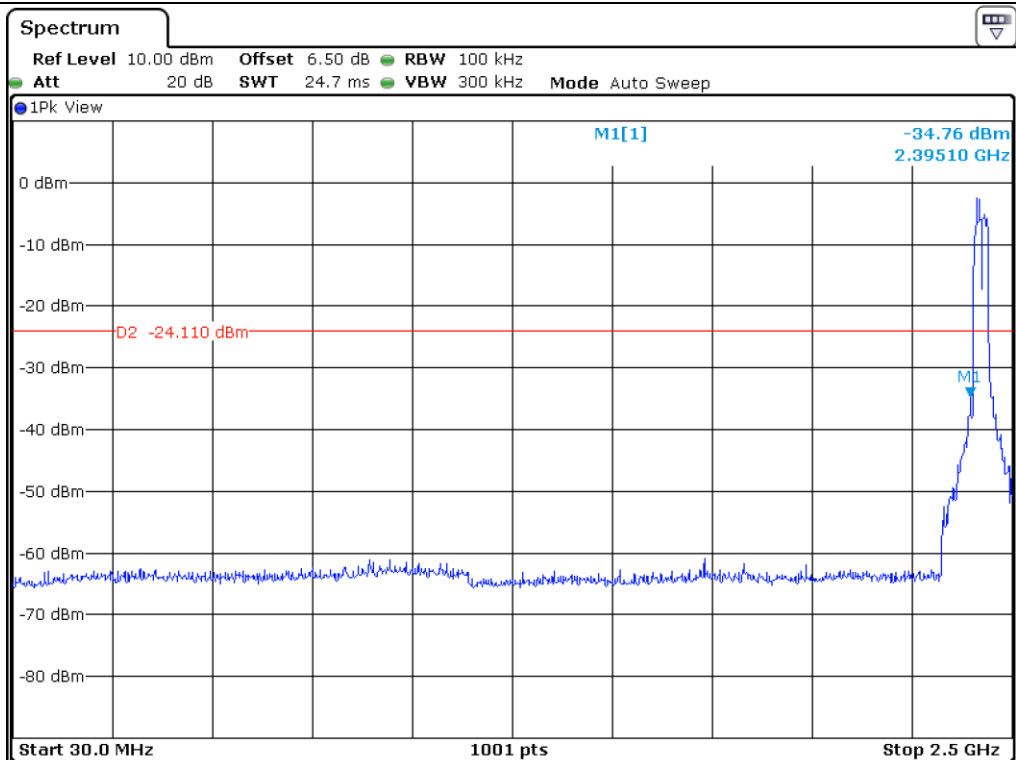
	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
■ -	ESR	Rohde & Schwarz	EMI Test Receiver	101470	Oct. 22, 2018 (1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Mar. 28, 2018 (1Y)
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug 23, 2018 (1Y)
■ -	BBV 9718 B	Schwarzbeck	Broadband Preamplifier	009	Mar. 16, 2018 (1Y)
■ -	MA-4000XPET	Innco Systems GmbH	Antenna Master	MA4000/509	N/A
□ -	HD100	HD GmbH	Position Controller	N/A	N/A
■ -	DT3000-3t	Innco Systems GmbH	Turn Table	N/A	N/A
□ -	FMZB 1513	Schwarzbeck	LOOP ANTENNA	1513-235	May. 13, 2018 (2Y)
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-235	Jun. 05, 2018 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 16, 2017 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA91700179	Jul. 28, 2017 (2Y)
■ -	SCU40A	Rohde & Schwarz	Pre-Amplifier	100436	Mar. 15, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

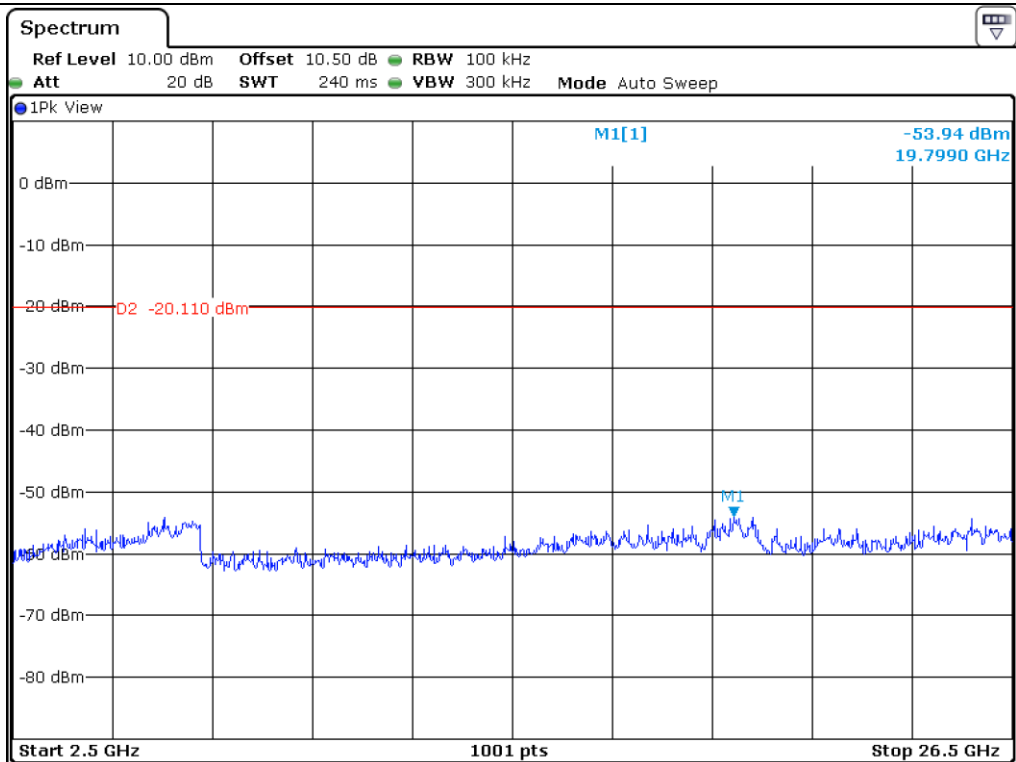
9.5 Test data for conducted emission



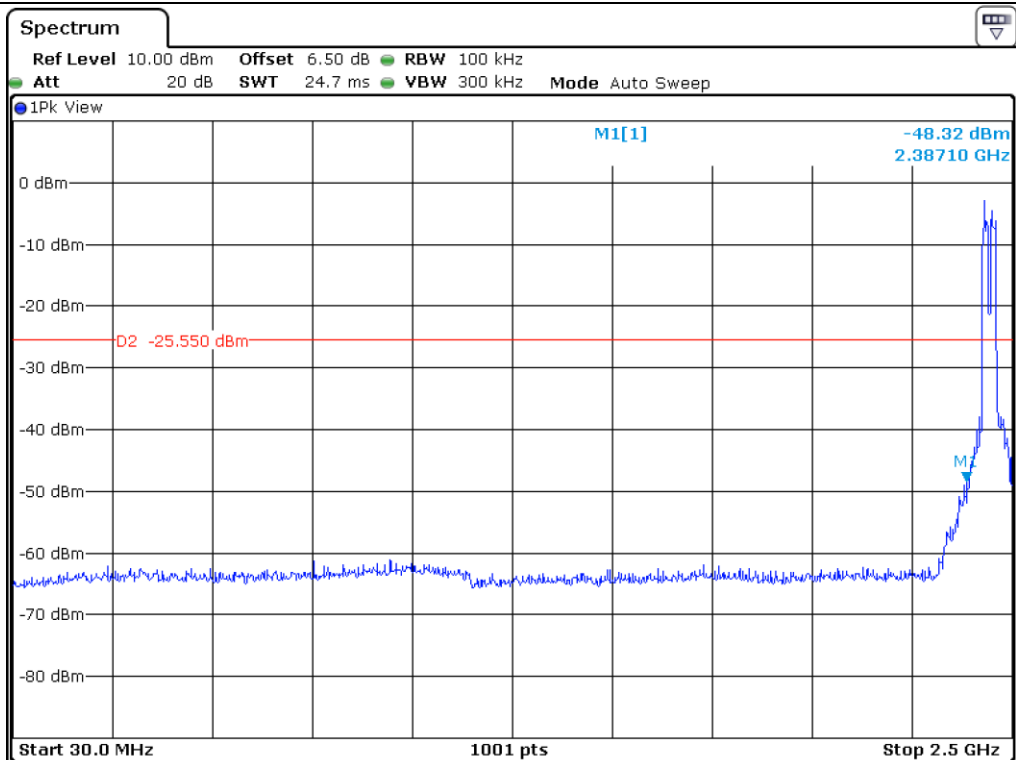




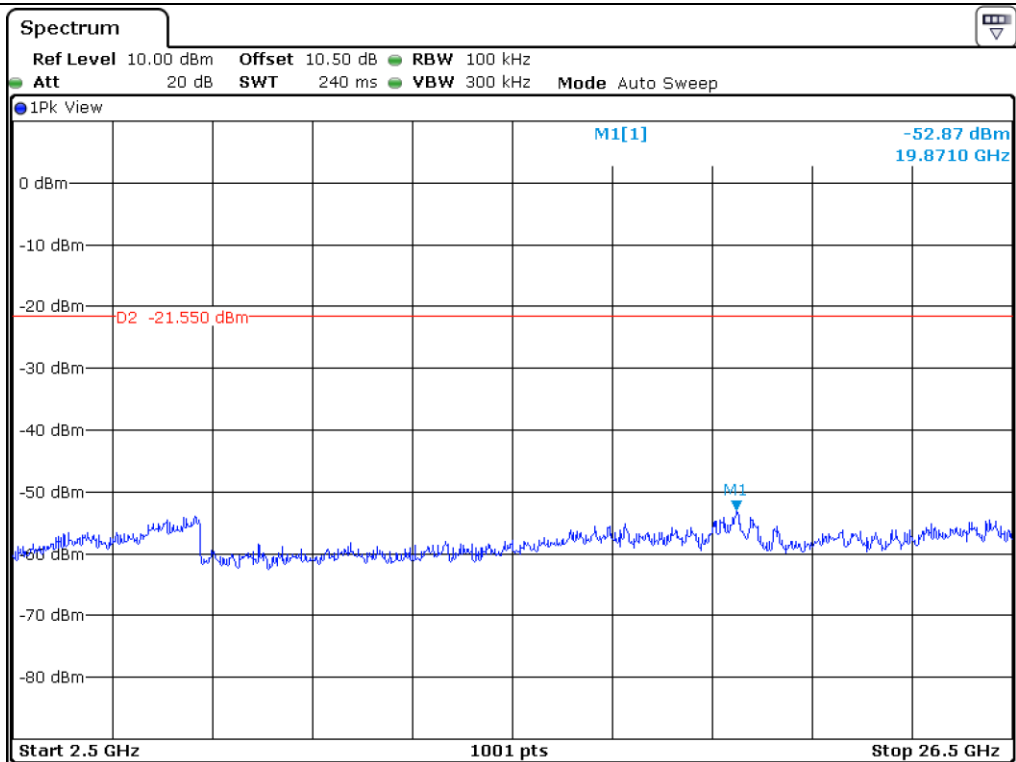
Low Channel



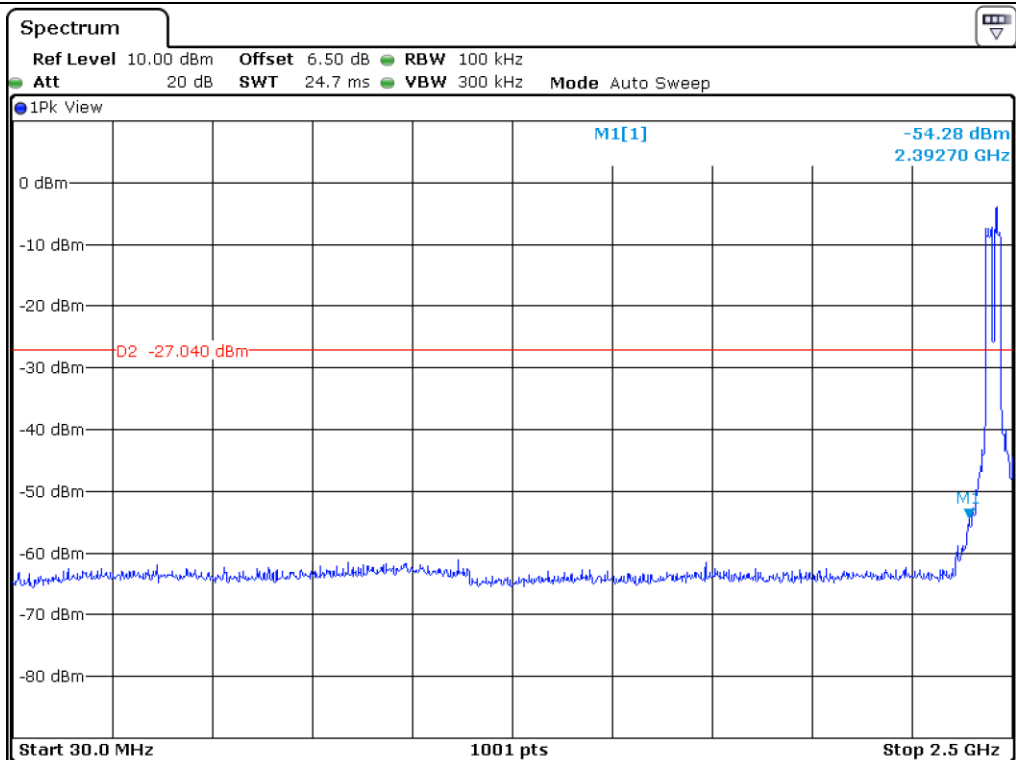
Low Channel



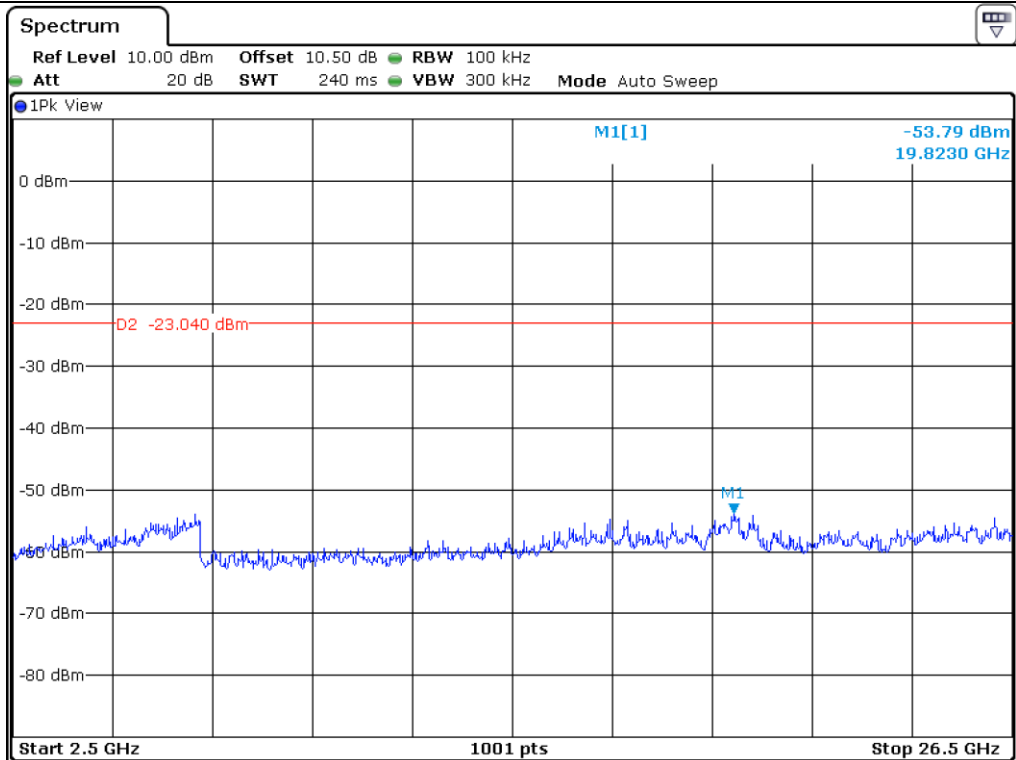
Middle Channel



Middle Channel



High Channel



High Channel

9.6 Test data for radiated emission

9.6.1 Radiated Emission which fall in the Restricted Band (DC 12 V)

- . Test Date : October 22, 2018 ~ November 23, 2018
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Measurement distance : 3 m
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2364.31	33.25	Peak	H	27.60	8.80	34.32	35.33	74.00	38.67
2364.31	19.42	Average	H				21.50	54.00	32.50
2316.91	32.59	Peak	V				34.67	74.00	39.33
2316.91	17.79	Average	V				19.87	54.00	34.13
Test Data for High Channel									
2484.73	34.37	Peak	H	27.70	9.00	34.46	36.61	74.00	37.39
2484.73	20.45	Average	H				22.69	54.00	31.31
2484.00	33.68	Peak	V				35.92	74.00	38.08
2496.15	20.06	Average	V				22.30	54.00	31.70

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Pre-Amplifier Gain}$$



Tested by: Ha-Ram, Lee / Assistant Manager

9.6.2 Radiated Emission which fall in the Restricted Band (DC 24 V)

- . Test Date : October 22, 2018 ~ November 23, 2018
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Measurement distance : 3 m
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2364.31	32.79	Peak	H	27.60	8.80	34.32	34.87	74.00	39.13
2364.31	19.43	Average	H				21.51	54.00	32.49
2358.87	32.56	Peak	V				34.64	74.00	39.36
2341.05	19.45	Average	V				21.53	54.00	32.47
Test Data for High Channel									
2492.43	33.49	Peak	H	27.70	9.00	34.46	35.73	74.00	38.27
2483.51	19.93	Average	H				22.17	54.00	31.83
2483.51	34.35	Peak	V				36.59	74.00	37.41
2483.51	19.84	Average	V				22.08	54.00	31.92

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss – Pre-Amplifier Gain



Tested by: Ha-Ram, Lee / Assistant Manager

9.6.3 Spurious & Harmonic Radiated Emission (DC 12 V)

- Test Date : October 22, 2018 ~ November 23, 2018
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Detector : Peak Mode(Peak), Average Mode(RMS)
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Result : PASSED

Frequency (GHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 844.00	43.96	Peak	H	31.30	13.40	35.23	53.43	74.00	20.57
	33.65	Average	H				43.12	54.00	10.88
	44.34	Peak	V				53.81	74.00	20.19
	33.77	Average	V				43.24	54.00	10.76
Test Data for Middle Channel									
4 884.00	43.89	Peak	H	31.10	13.60	35.26	53.33	74.00	20.67
	33.09	Average	H				42.53	54.00	11.47
	43.61	Peak	V				53.05	74.00	20.95
	33.54	Average	V				42.98	54.00	11.02
Test Data for High Channel									
4 904.00	44.89	Peak	H	31.10	13.70	35.29	54.40	74.00	19.60
	33.05	Average	H				42.56	54.00	11.44
	44.34	Peak	V				53.85	74.00	20.15
	32.96	Average	V				42.47	54.00	11.53

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss – Pre-Amplifier Gain



Tested by: Ha-Ram, Lee / Assistant Manager

9.6.4 Spurious & Harmonic Radiated Emission (DC 24 V)

- Test Date : October 22, 2018 ~ November 23, 2018
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Detector : Peak Mode(Peak), Average Mode(RMS)
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Result : PASSED

Frequency (GHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 844.00	44.12	Peak	H	31.30	13.40	35.23	53.59	74.00	20.41
	33.46	Average	H				42.93	54.00	11.07
	44.46	Peak	V				53.93	74.00	20.07
	33.35	Average	V				42.82	54.00	11.18
Test Data for Middle Channel									
4 884.00	44.39	Peak	H	31.10	13.60	35.26	53.83	74.00	20.17
	33.31	Average	H				42.75	54.00	11.25
	45.33	Peak	V				54.77	74.00	19.23
	32.91	Average	V				42.35	54.00	11.65
Test Data for High Channel									
4 904.00	44.77	Peak	H	31.10	13.70	35.29	54.28	74.00	19.72
	33.31	Average	H				42.82	54.00	11.18
	43.45	Peak	V				52.96	74.00	21.04
	33.02	Average	V				42.53	54.00	11.47

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss – Pre-Amplifier Gain



Tested by: Ha-Ram, Lee / Assistant Manager

10. PEAK POWER SPECTRAL DENSITY

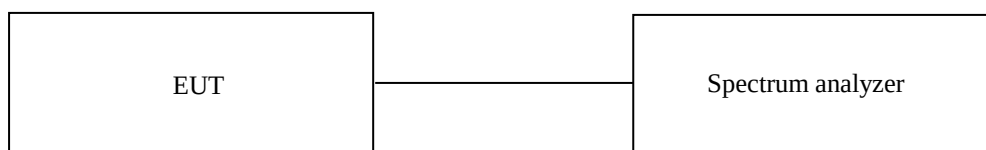
10.1 Operating environment

Temperature : 25 °C
Relative humidity : 46 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$, the video bandwidth is set to 3 times the resolution bandwidth.



10.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug 23, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

10.4 Test data for DC 12 V

-. Test Date : October 22, 2018 ~ November 23, 2018

-. Test Result : Pass

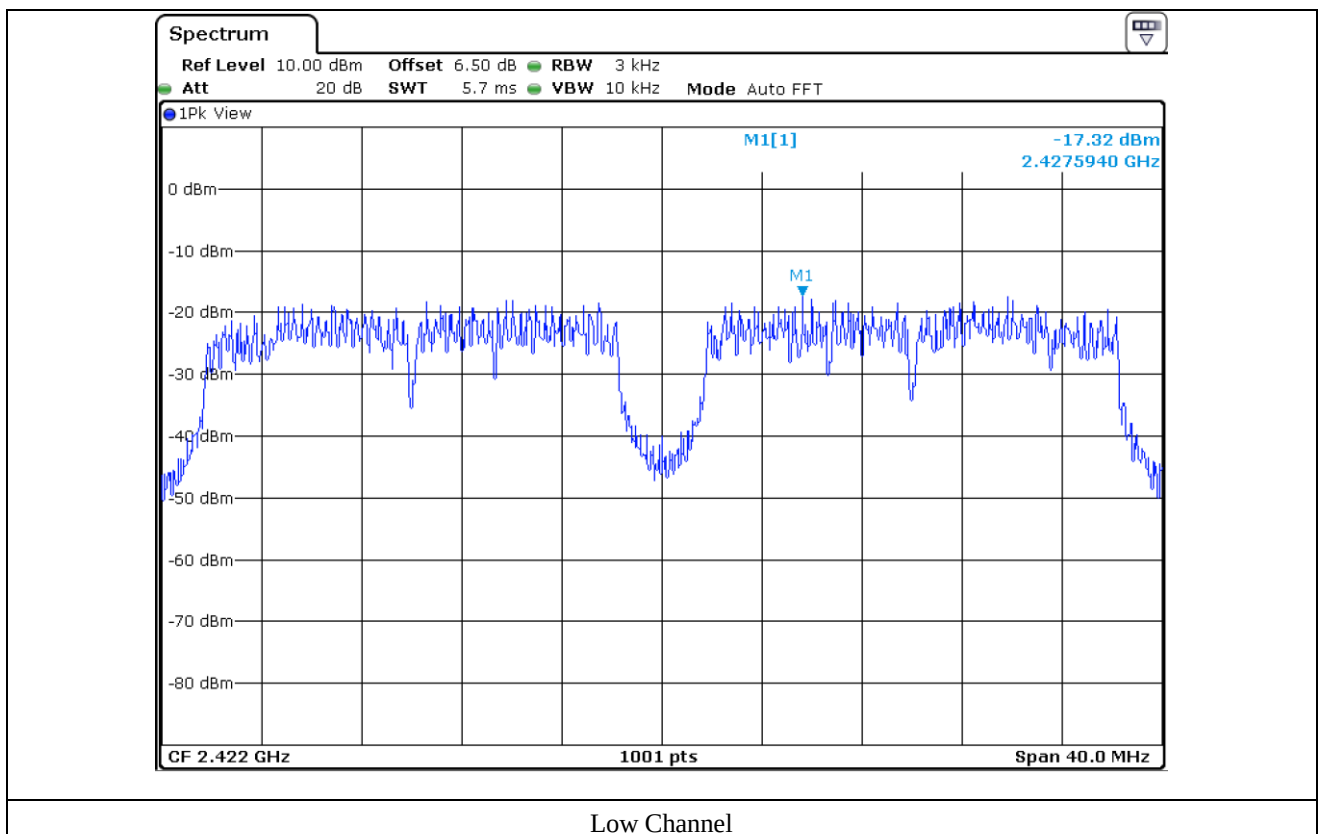
-. Operating Condition : Continuous transmitting mode

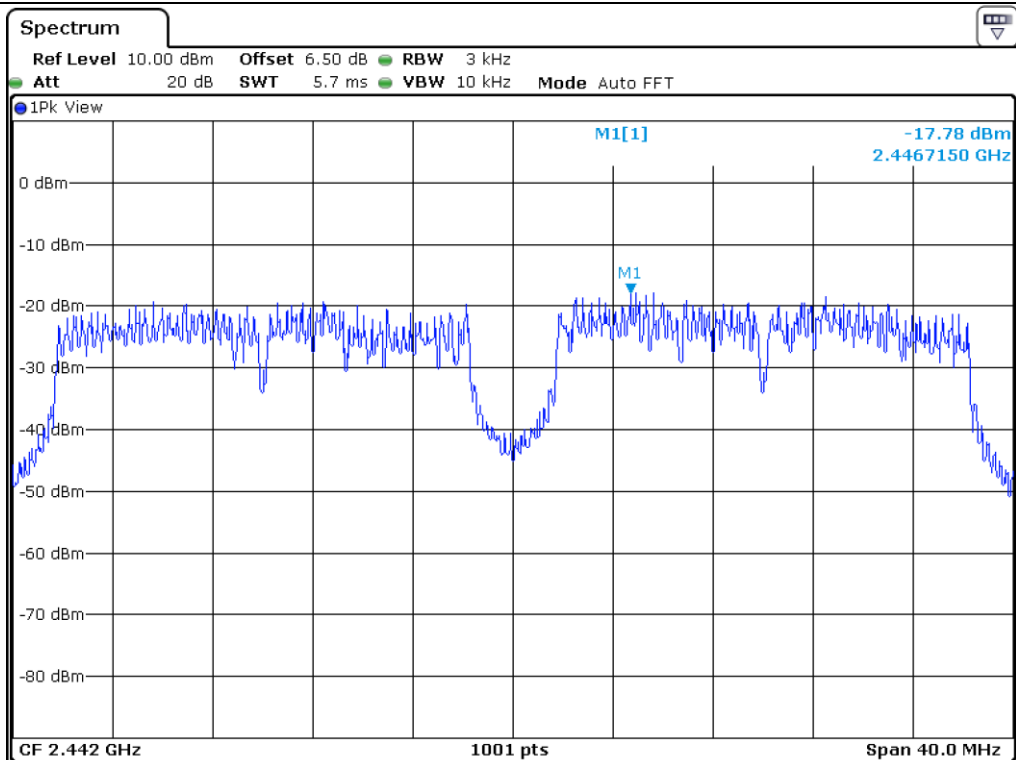
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 422.00	-17.32	8.00	25.32
Middle	2 442.00	-17.78	8.00	25.78
High	2 452.00	-19.16	8.00	27.16

Remark. Margin = Limit – Measured value

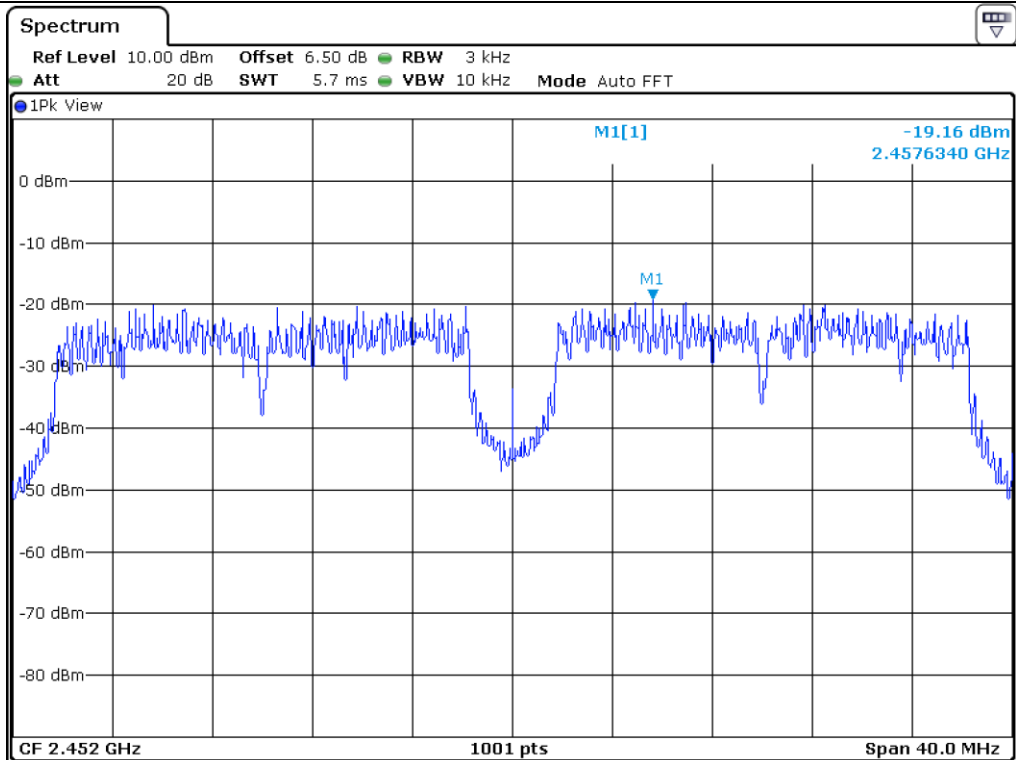


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

10.5 Test data for DC 24 V

-. Test Date : October 22, 2018 ~ November 23, 2018

-. Test Result : Pass

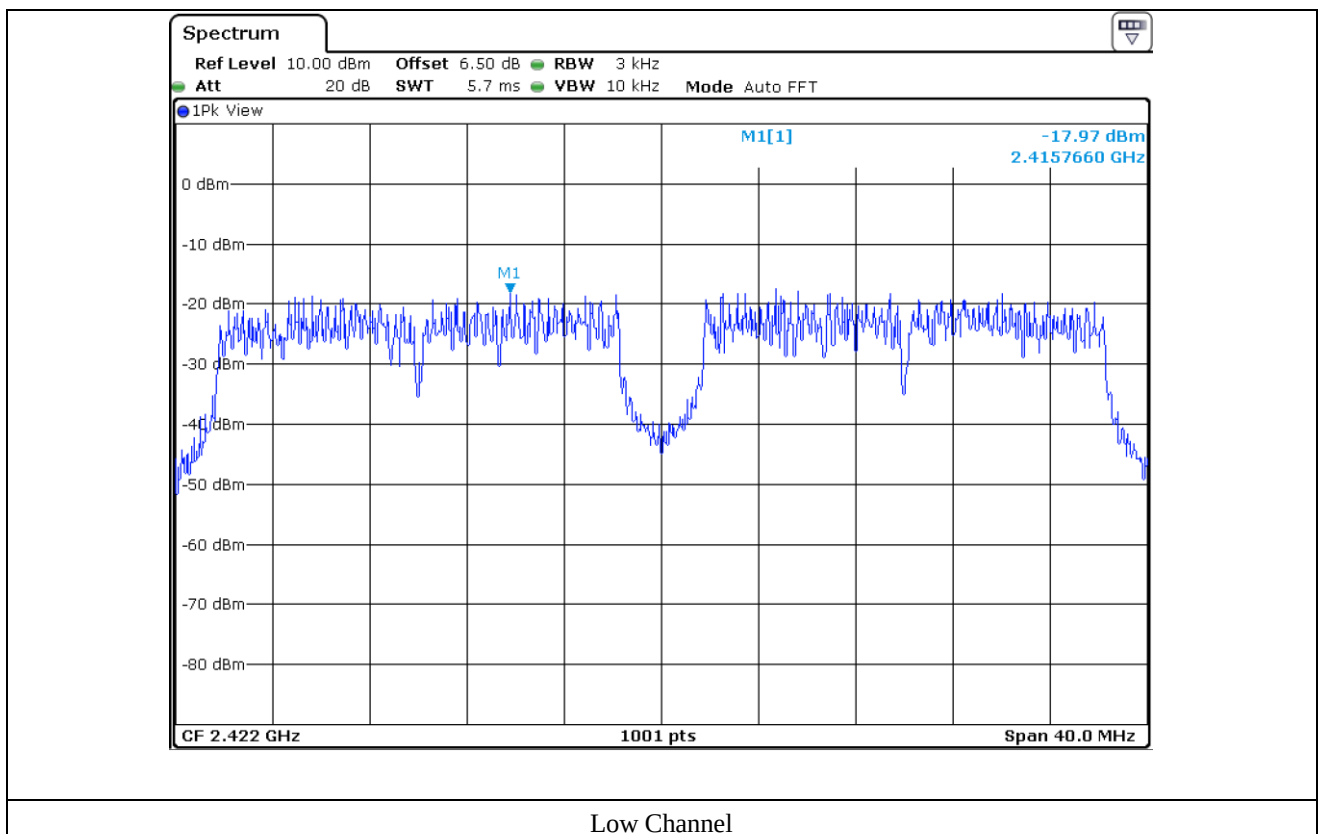
-. Operating Condition : Continuous transmitting mode

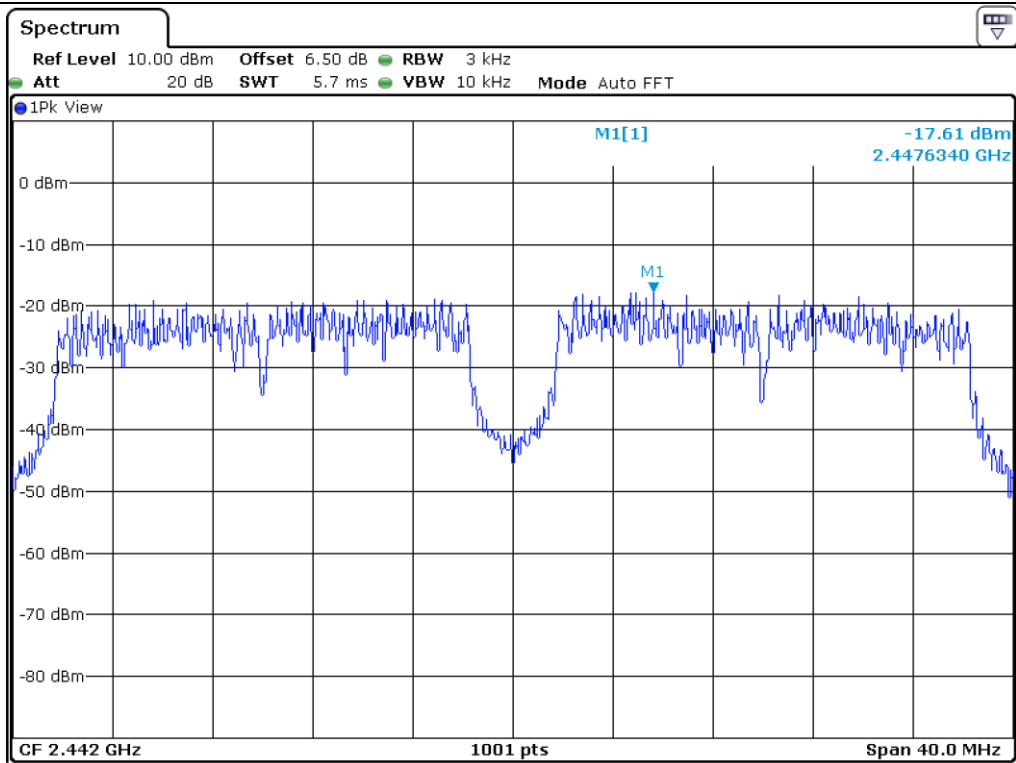
CHANNEL	FREQUENCY(MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
Low	2 422.00	-17.97	8.00	25.97
Middle	2 442.00	-17.61	8.00	25.61
High	2 452.00	-19.20	8.00	27.20

Remark. Margin = Limit – Measured value

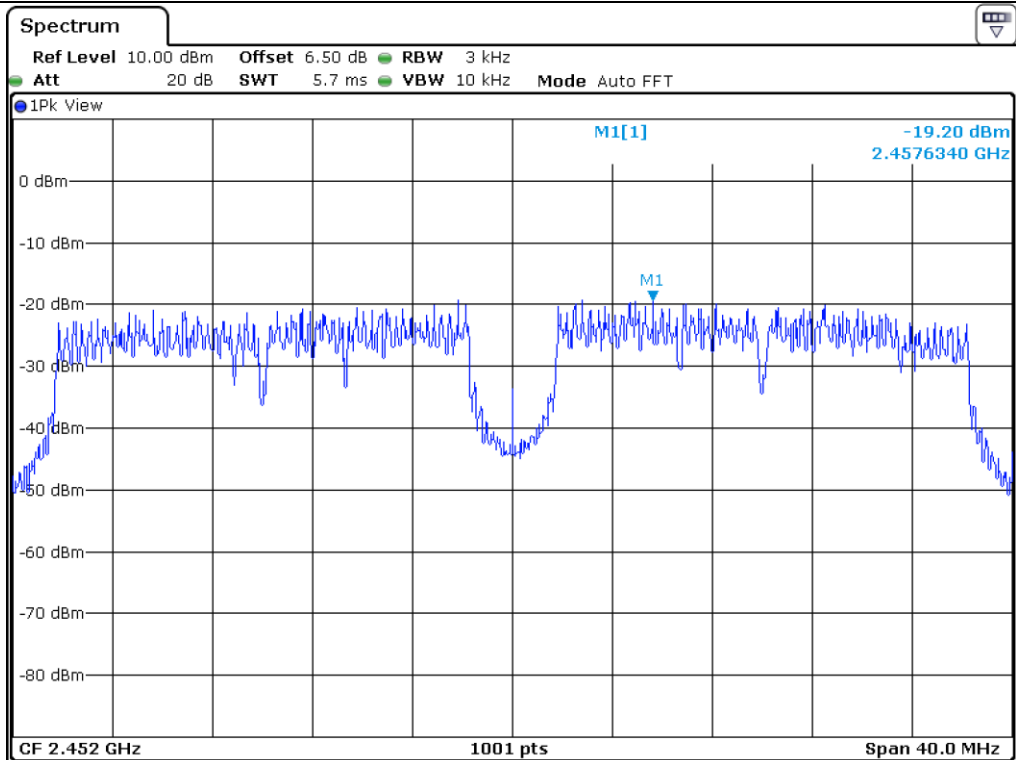


Tested by: Ha-Ram, Lee / Assistant Manager





Middle Channel



High Channel

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 25 °C
Relative humidity : 46 % R.H.

11.2 Test set-up

The radiated emissions measurements were on the 3 m semi anechoic chamber. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

11.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
■ -	ESR	Rohde & Schwarz	EMI Test Receiver	101470	Oct. 22, 2018 (1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Mar. 28, 2018 (1Y)
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101200	Aug 23, 2018 (1Y)
■ -	BBV 9718 B	Schwarzbeck	Broadband Preamplifier	009	Mar. 16, 2018 (1Y)
■ -	MA-4000XPET	Innco Systems GmbH	Antenna Master	MA4000/509	N/A
□ -	HD100	HD GmbH	Position Controller	N/A	N/A
■ -	DT3000-3t	Innco Systems GmbH	Turn Table	N/A	N/A
□ -	FMZB 1513	Schwarzbeck	LOOP ANTENNA	1513-235	May. 13, 2018 (2Y)
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-235	Jun. 05, 2018 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 16, 2017 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA91700179	Jul. 28, 2017 (2Y)
■ -	SCU40A	Rohde & Schwarz	Pre-Amplifier	100436	Mar. 15, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

11.4 Test data for Transmitting Mode

11.4.1 Test data for 30 MHz ~ 1 GHz (DC 12 V)

Humidity Level : 46 % R.H.

Temperature: 25 °C

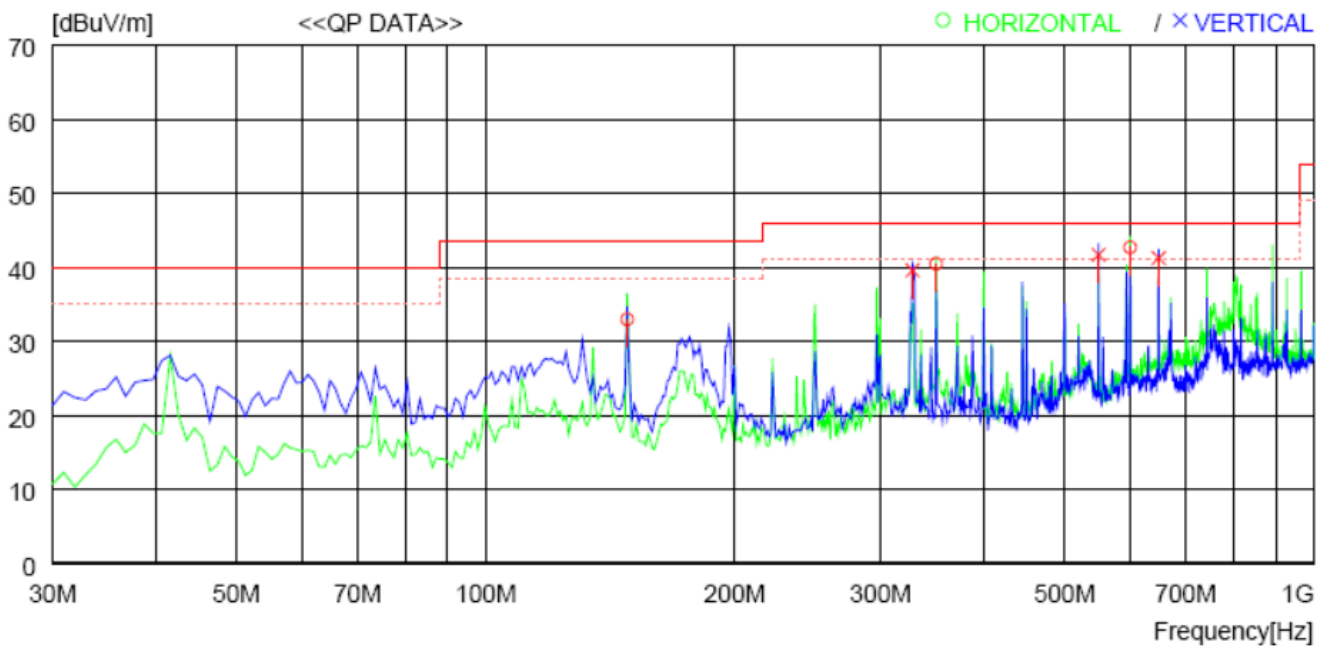
Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : BlackBox

Date: October 22, 2018 ~ November 23, 2018

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
---- Horizontal ----										
1	148.340	54.7	8.1	3.2	33.0	33.0	43.5	10.5	200	270
2	350.100	53.7	14.8	5.0	33.0	40.5	46.0	5.5	100	0
3	600.358	50.0	19.4	6.6	33.3	42.7	46.0	3.3	100	257
---- Vertical ----										
4	327.790	53.6	14.2	4.8	33.0	39.6	46.0	6.4	100	359
5	549.919	50.8	17.9	6.3	33.3	41.7	46.0	4.3	100	359
6	649.826	48.3	19.4	6.9	33.3	41.3	46.0	4.7	100	357

[Signature]

Tested by: Ha-Ram, Lee / Assistant Manager

11.4.2 Test data for 30 MHz ~ 1 GHz (DC 24 V)

Humidity Level : 46 % R.H.

Temperature: 25 °C

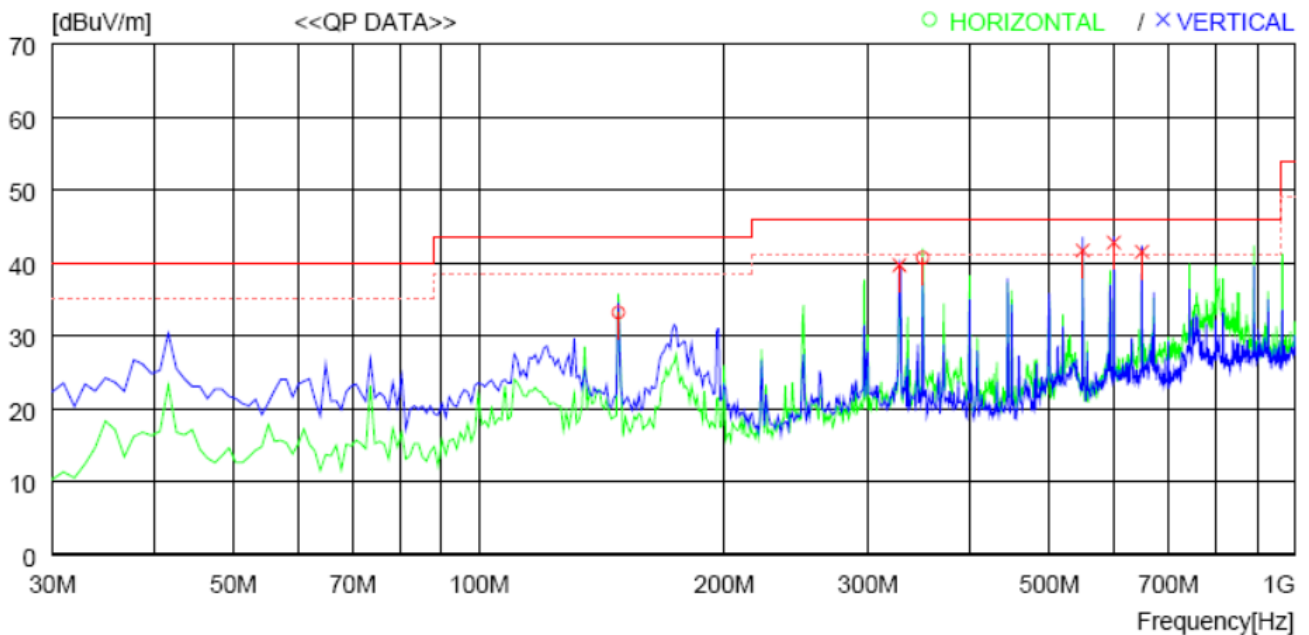
Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : BlackBox

Date: October 22, 2018 ~ November 23, 2018

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	[dBuV]	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	148.340	54.9	8.1	3.2	33.0	33.2	43.5	10.3	200	359
2	350.100	53.9	14.8	5.0	33.0	40.7	46.0	5.3	100	116
----- Vertical -----										
3	327.790	53.7	14.2	4.8	33.0	39.7	46.0	6.3	100	359
4	549.919	50.8	17.9	6.3	33.3	41.7	46.0	4.3	100	221
5	600.358	50.1	19.4	6.6	33.3	42.8	46.0	3.2	100	240
6	649.826	48.5	19.4	6.9	33.3	41.5	46.0	4.5	100	172



Tested by: Ha-Ram, Lee / Assistant Manager

11.4.3 Test data for Below 30 MHz

- . Test Date : October 22, 2018 ~ November 23, 2018
- . Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)
- . Frequency range : 9 kHz ~ 30 MHz
- . Measurement distance : 3 m
- . Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Any emissions less than 20 dB below the limit were not observed.									

11.4.4 Test data for above 1 GHz

- . Test Date : October 22, 2018 ~ November 23, 2018
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 1 MHz for Peak Mode, 10 Hz for Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Any emissions less than 20 dB below the limit were not observed.									



Tested by: Ha-Ram, Lee / Assistant Manager