On your side

TEST REPORT

FCC BT LE Test for T7

APPLICANT VC Inc.

REPORT NO. HCT-RF-2002-FC019-R1

DATE OF ISSUE March 10, 2020

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Eut Type Model Name	Voice Caddie Hybrid Golf Watch T7
FCC ID:	2ABTKT7
RF Peak Output Power:	-0.313 dBm (0.930 mW)
Modulation type	GFSK
FCC Classification: FCC Rule Part(s):	Digital Transmission System(DTS) Part 15.247
Frequency alignment range	2 402 MHz ~ 2 480 MHz

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.

This test results were applied only to the test methods required by the standard.

Tested by Jung Ki Lim

Technical Manager Jong Seok Lee

HCT CO., LTD. Soo Chan Lee



REVISION HISTORY

The revision history for this test report is shown in table.

Revision No. Date of Issue		Description		
0	February 26, 2020	Initial Release		
1	March 10, 2020	Retest the 6dB BW for 1M(Bit/s)		



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1. EUT DESCRIPTION

Model	Т7	Т7		
ЕИТ Туре	Voice Cade	Voice Caddie Hybrid Golf Watch		
Power Supply	DC 3.7 V			
Frequency Range	2402 MHz	- 2480 MHz		
Max. RF Output Power	Peak 1M Bit/s - 37 byte : -0.383 dBm (0.916 mW) - 255 byte : -0.380 dBm (0.916 mW) 2M Bit/s - 37 byte: -0.324 dBm (0.928 mW) - 255 byte : -0.313 dBm (0.930 mW) - 255 byte : -0.313 dBm (0.930 mW) - 255 byte: -0.56 dBm (0.879 mW) - 255 byte: -0.43 dBm (0.906 mW) 2M Bit/s - 37 byte: -0.61 dBm (0.869 mW) - 255 bytes: -0.42 dBm (0.908 mW)			
Modulation Type	GFSK			
Bluetooth Version	5.0			
Number of Channels	40 Channe	ls		
Antenna Specification	Antenna type: Dielectric Chip Antenna Peak Gain : 1.80 dBi			
Date(s) of Tests	-	18, 2020 ~ February 25, 2020 D, 2020 (Rev1)		



2. TEST METHODOLOGY

FCC KDB 558074 D01 15.247 Meas Guidance v05r02 dated April 02, 2019 entitled "guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices and the measurement procedure described in ANSI C63.10(Version : 2013) 'the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices'.

EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpse of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3.75 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 6.6.5 of ANSI C63.10. (Version: 2013)



DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment's, which is traceable to recognized national standards.

Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

4. FACILITIES AND ACCREDITATIONS

FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil,

Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA.

The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.

Detailed description of test facility was submitted to the Commission and accepted dated April 02, 2018 (Registration Number: KR0032).

EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."





5. ANTENNA REQUIREMENTS

According to FCC 47 CFR § 15.203 / RSS-Gen(Issue 5) Section 8:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

(1) The antennas of this E.U.T are permanently attached.

(2) The E.U.T Complies with the requirement of § 15.203

6. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95 % level of confidence.

The measurement data shown herein meets or exceeds the *U*_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

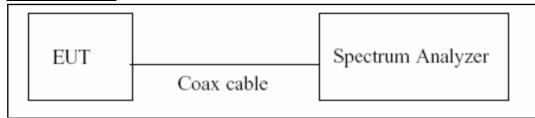
Parameter	Expanded Uncertainty (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.82
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70
Radiated Disturbance (18 GHz ~ 40 GHz)	5.05



7. DESCRIPTION OF TESTS

7.1. Duty Cycle

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to the zero-span measurement method, 6.0)b) in KDB 558074 v05r02.

The largest availble value of RBW is 8 MHz and VBW is 50 MHz.

The zero-span method of measuring duty cycle shall not be used if T \leq 6.25 microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/*T*.

- 1. RBW = 8 MHz (the largest availble value)
- 2. VBW = 8 MHz (\geq RBW)
- 3. SPAN = 0 Hz
- 4. Detector = Peak
- 5. Number of points in sweep > 100
- 6. Trace mode = Clear write
- 7. Measure T_{total} and T_{on}
- 8. Calculate Duty Cycle = T_{on}/T_{total} and Duty Cycle Factor = 10log(1/Duty Cycle)





7.2. 6dB Bandwidth

Limit

The minimum permissible 6 dB bandwidth is 500 kHz.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 8.2 in KDB 558074 v05r02,

Procedure 11.8.1 in ANSI 63.10-2013)

- 1) RBW = 100 kHz
- 2) VBW \geq 3 x RBW
- 3) Detector = Peak
- 4) Trace mode = max hold
- 5) Sweep = auto couple
- 6) Allow the trace to stabilize
- 7) We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

Note : We tested OBW using the automatic bandwidth measurement capability of a spectrum analyzer.

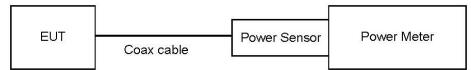


7.3. Output Power

Limit

The maximum permissible conducted output power is 1 Watt.

Test Configuration



Test Procedure

The transmitter output is connected to the Power Meter.

- Peak Power (Procedure 11.9.1.3 in ANSI 63.10-2013)
- : Measure the peak power of the transmitter.
- Average Power (Procedure 8.3.2.3 in KDB 558074 v05r02, Procedure 11.9.2.3 in ANSI 63.10-2013)
 - 1) Measure the duty cycle.
 - 2) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
 - 3) Add 10 $\log(1/x)$, where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

Sample Calculation

- Conducted Output Power(Peak) = Reading Value + ATT loss + Cable loss
- Conducted Output Power(Average) = Reading Value + ATT loss + Cable loss + Duty Cycle Factor

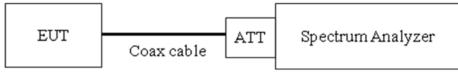


7.4. Power Spectral Density

Limit

The transmitter power density average over 1-second interval shall not be greater than 8dBm in any 3 kHz BW.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to Procedure 8.4 in KDB 558074 v05r02, Procedure 11.10 in ANSI 63.10-2013.

The spectrum analyzer is set to :

- 1) Set analyzer center frequency to DTS channel center frequency.
- 2) Set span to at least 1.5 times the OBW.
- 3) RBW = 3 kHz \leq RBW \leq 100 kHz.
- 4) VBW \geq 3 x RBW.
- 5) Sweep = auto couple
- 6) Detector = Peak
- 7) Trace mode = max hold
- 8) Allow trace to fully stablize.
- 9) Use the peak marker function to determine the maximum amplitude level.
- Use the peak marker function to determine the maximum amplitude level within the RBW.
 If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Sample Calculation

Power Spectral Density = Reading Value + ATT loss + Cable loss

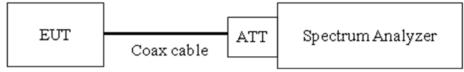


7.5. Conducted Band Edge(Out of Band Emissions) & Conducted Spurious Emissions

Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

Test Configuration



Test Procedure

The transmitter output is connected to the spectrum analyzer.

(Procedure 8.5 in KDB 558074 v05r02, Procedure 11.11 in ANSI 63.10-2013)

- 1) RBW = 100 kHz
- 2) VBW \geq 3 x RBW
- 3) Set span to encompass the spectrum to be examined
- 4) Detector = Peak
- 5) Trace Mode = max hold
- 6) Sweep time = auto couple
- 7) Ensure that the number of measurement points \geq 2 x Span/VBW
- 8) Allow trace to fully stabilize.
- 9) Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 25 GHz range with the transmitter set to the lowest, middle, and highest channels.



Factors for frequency

Freq(MHz)	Factor(dB)
30	10.04
100	10.07
200	10.12
300	10.17
400	10.20
500	10.21
600	10.21
700	10.23
800	10.24
900	10.26
1000	10.27
2000	10.41
2400	10.45
2500	10.47
3000	10.52
4000	10.60
5000	10.71
6000	10.73
7000	10.80
8000	10.85
9000	10.91
10000	10.97
11000	11.02
12000	11.10
13000	11.19
14000	11.16
15000	11.21
16000	11.22
17000	11.25
18000	11.30
19000	11.32
20000	11.36
21000	11.48
22000	11.55
23000	11.55
24000	11.59
25000	11.68
26000	11.69

Note : 1. 2 400 ~ 2 500 MHz is fundamental frequency range.

2. Factor = Attenuator loss + Cable loss



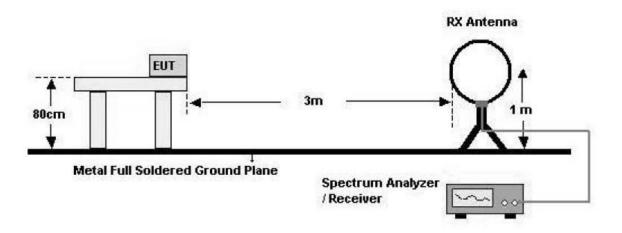
7.6. Radiated Test

Limit

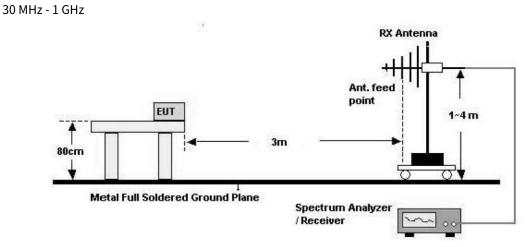
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Test Configuration

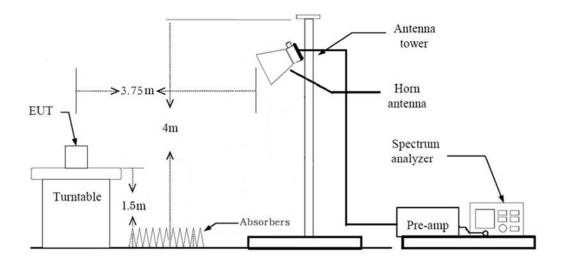
Below 30 MHz







Above 1 GHz







Test Procedure of Radiated spurious emissions(Below 30 MHz)

- 1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
- 2. The loop antenna was placed at a location 3m from the EUT
- 3. The EUT is placed on a turntable, which is 0.8m above ground plane.
- 4. We have done x, y, z planes in EUT and horizontal and vertical polarization and Parallel to the ground plane in detecting antenna.

5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.

- 6. Distance Correction Factor(0.009 MHz 0.490 MHz) = 40log(3 m/300 m) = 80 dB Measurement Distance : 3 m
- 7. Distance Correction Factor(0.490 MHz 30 MHz) = 40log(3 m/30 m) = 40 dB Measurement Distance : 3 m
- 8. Spectrum Setting
 - Frequency Range = 9 kHz ~ 30 MHz
 - Detector = Peak
 - Trace = Maxhold
 - RBW = 9 kHz
 - VBW \geq 3 x RBW

9. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

KDB 414788 OFS and Chamber Correlation Justification

Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

OFS and chamber correlation testing had been performed and chamber measured test result is the worst case test result.



Test Procedure of Radiated spurious emissions(Below 1GHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.

2. The EUT is placed on a turntable, which is 0.8m above ground plane.

3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.

- 5. Spectrum Setting
 - (1) Measurement Type(Peak):
 - Measured Frequency Range : 30 MHz 1 GHz
 - Detector = Peak
 - Trace = Maxhold
 - RBW = 100 kHz
 - VBW \geq 3 x RBW
 - (2) Measurement Type(Quasi-peak):
 - Measured Frequency Range : 30 MHz 1 GHz
 - Detector = Quasi-Peak
 - RBW = 120 kHz
 - In general, (1) is used mainly
- 6. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L)

7. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.



Test Procedure of Radiated spurious emissions (Above 1 GHz)

- 1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
- 2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
- 3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
- 4. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
- 5. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor(reference distance : 3 m).
 - Distance extrapolation factor = 20log (test distance / specific distance) (dB)
- 6. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 7. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
- 8. The unit was tested with its standard battery.
- 9. Spectrum Setting (Method 8.6 in KDB 558074 v05r02, Procedure 11.12 in ANSI 63.10-2013)
 - (1) Measurement Type(Peak):
 - Measured Frequency Range : 1 GHz 25 GHz
 - Detector = Peak
 - Trace = Maxhold
 - RBW = 1 MHz
 - VBW \geq 3 x RBW
 - (2) Measurement Type(Average):
 - Average value of pulsed emissions
 - Unless otherwise specified, when the radiated emission limits are expressed in terms of the average value of the emission and pulsed operation is employed, the average measurement shall determined from the peak field strength after correcting for the worst-case duty cycle as described in section 9.6
 - DCCF = 20log₁₀(Worst Case Dwell Time / 100ms)

10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.



11. Total(Measurement Type : Peak)

= Peak Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

Total(Measurement Type : Average)

- = Peak Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) Amp Gain(G) + Distance Factor(D.F)
- + Duty Cycle Correction Factor



Test Procedure of Radiated Restricted Band Edge

- 1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
- 2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
- 3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
- 4. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
- 5. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor(reference distance : 3 m).
 - Distance extrapolation factor = 20log (test distance / specific distance) (dB)
- 6. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 7. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
- 8. The unit was tested with its standard battery.
- 9. Spectrum Setting
 - (1) Measurement Type(Peak):
 - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz
 - Detector = Peak
 - Trace = Maxhold
 - RBW = 1 MHz
 - VBW \geq 3 x RBW
 - (2) Measurement Type(Average):
 - Duty cycle < 98%, duty cycle variations are less than $\pm 2\%$
 - Measured Frequency Range : 2310 MHz \sim 2390 MHz/ 2483.5 MHz \sim 2500 MHz
 - Detector = RMS
 - Averaging type = power (*i.e.*, RMS)
 - RBW = 1 MHz
 - VBW \geq 3 x RBW
 - Sweep time = auto.
 - Trace mode = average (at least 100 traces).
 - Correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.
 - Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.



- 10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
- 11. Total(Measurement Type : Peak
 - = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

Total(Measurement Type : Average

= Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F) + Duty Cycle Factor



7.7. AC Power line Conducted Emissions

Limit

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50μ H/50 ohms line impedance stabilization network (LISN).

Frequency Pango (MHz)	Limits (dBµV)			
Frequency Range (MHz)	Quasi-peak	Average		
0.15 to 0.50	66 to 56 ^(a)	56 to 46 ^(a)		
0.50 to 5	56	46		
5 to 30	60	50		

^(a)Decreases with the logarithm of the frequency.

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Annex A for the actual connections between EUT and support equipment.

Test Procedure

- 1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
- 2. The EUT is connected via LISN to a test power supply.
- 3. The measurement results are obtained as described below:
- 4. Detectors : Quasi Peak and Average Detector.

Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor



7.8. Worst case configuration and mode

Radiated Test

1. All modes of operation were investigated and the worst case configuration results are reported.

- Mode : Stand alone, Stand alone + External accessories(Craddle, et)
- Worstcase : Stand alone
- 2. EUT Axis:
 - Radiated Spurious Emissions : Z
 - Radiated Restricted Band Edge : Z
- 3. All packet length of operation were investigated and the test results are worst case in lowest packet length.
 - (Worst case : 255 Byte)

4. All position of loop antenna were investigated and the test result is a no critical peak found at all positions.

- Position : Horizontal, Vertical, Parallel to the ground plane

AC Power line Conducted Emissions

1. All modes of operation were investigated and the worst case configuration results are reported.

Conducted test

1. The EUT was configured with packet length of highest power. (Worst case : 255 Byte)



8. SUMMARY TEST OF RESULTS

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§ 15.247(a)(2)	> 500 kHz		PASS
Conducted Maximum Output Power	§ 15.247(b)(3)	< 1 Watt		PASS
Power Spectral Density	§ 15.247(e)	< 8 dBm / 3 kHz Band	Conducted	PASS
Band Edge (Out of Band Emissions)	§ 15.247(d)	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	§ 15.207	cf. Section 7.7		PASS
Radiated Spurious Emissions	§ 15.247(d), 15.205, 15.209	cf. Section 7.6	Dedicted	PASS
Radiated Restricted Band Edge	§ 15.247(d), 15.205, 15.209	cf. Section 7.6	Radiated	PASS



9. TEST RESULT

9.1 DUTY CYCLE

Data rate (Bit/s)	Packet length (Byte)	T _{on} (ms)	T _{total} (ms)	Duty Cycle	Duty Cycle Factor (dB)
114	37	0.3620	0.4800	0.7542	1.23
1M	255	2.1050	2.2250	0.9461	0.24
214	37	0.1881	0.3063	0.6143	2.12
2M	255	1.0600	1.1780	0.8998	0.46



IM Bit/s (37 Byte) Test Plots

RL	n Analyzer - Swept S RF 50 Q AC Q 2.4020000		SENSE:INT	(LOW-CH 0)	10:40:58 AM Feb 19, 20 TRACE 12.3 4 TYPE	5.6 Frequency
	Ref Offset 10.47 (Ref 15.00 dBn	IFGain:Low	Atten: 16 dB		∆Mkr3 480.0 µ 2.38 d	Auto Tur
5.00		X42		1Δ12	3 ∆4	Center Fre 2.402000000 GH
25.0 35.0 45.0						Start Fre 2.402000000 GH
55.0 65.0 75.0		halahaland		a, the start of th	₩	Stop Fre 2.402000000 Gi
tes BW 81		#VBW {			Span 0 I .000 ms (1001 pt	
MKR MODE TRC 1 Δ12 1 2 Ν 3 Δ4 1 4 F 1 5 6	t (Δ) t (Δ)	× 362.0 μs (Δ) 6 GHz 480.0 μs (Δ) 334.0 μs	Y F 8.77 dB dBm 2.38 dB -10.61 dBm	UNCTION FUNCTION WIDTH	FUNCTION VALUE	Freq Offs
7						

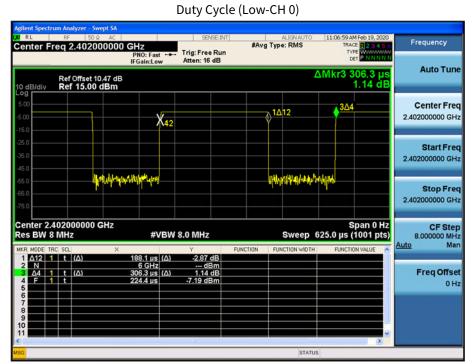
IM Bit/s (255 Byte) Test Plots

Duty Cycle (Low-CH 0)

LXIRL	um Analyzer - Swept RF 50 Ω req 2.402000	AC 000 GHz	SENSE:INT	#Avg	ALIGN AUTO Type: RMS	TRAC	4 Feb 19, 2020 8 <mark>1 2 3 4 5</mark> 6 €	Frequency
10 dB/div	Ref Offset 10.4 Ref 15.00 dB		Trig: Free Run Atten: 16 dB		Δ	Mkr3 2.	PNNNN	Auto Tune
5.00 -5.00 -15.0								Center Fred 2.402000000 GH:
-25.0 -35.0 -45.0								Start Free 2.402000000 GH
-55.0 -65.0 -75.0								Stop Free 2.402000000 GH
Res BW 8	RC SCL	#VBW	8.0 MHz	FUNCTION	Sweep 5			CF Step 8.000000 MH Auto Mar
1 Δ12 1 2 N 3 Δ4 1 4 F 1 5 6 7	t (Δ)	2.105 ms (Δ) 6 GHz 2.225 ms (Δ) 55.00 μs	0.04 dB dBm 0.03 dB -0.82 dBm					Freq Offse 0 Ha
8 9 10 11								
ISG					STATUS	5		



2M Bit/s (37 Byte) Test Plots



2M Bit/s (255 Byte) Test Plots

Duty Cycle (Low-CH 0)

Agilent Spectr												
Center F		0 0 0 AC	GHz		SENSE:IM	#Av	g Type: RM		TRA	M Feb 19, 202 CE 12345	6	Frequency
			PNO: Fast IFGain:Low		Trig: Free Ru Atten: 16 dB	1			D			Auto Tune
10 dB/div	Ref Offset Ref 15.0							Δ	Mkr3 1.	0.79 dE		
5.00							1∆1	2 3∆4				Center Freq
-5.00	\rightarrow	K42						Y				2.402000000 GHz
-15.0												
-35.0												Start Freq 2.402000000 GHz
-45.0	1.4							_				
-55.0	Ro.de.						- Andre		_			Stop Freq
-75.0												2.40200000 GHz
Center 2.4 Res BW 8	40200000 MHz	0 GHz	#V	BW	8.0 MHz		Swee	ep 2.	S .000 ms (pan 0 H 1001 pts)	CF Step 8.000000 MHz
MKR MODE TH		×	1.060 ms	(A)	Y 5.16 dB	FUNCTION	FUNCTION	WIDTH	FUNCTION	ON VALUE	^	<u>Auto</u> Man
2 N 3 Δ4 1	t (Δ)		6 GHz 1.178 ms		dBm 0.79 dB							Freq Offset
5	t		334.0 µs		-5.88 dBm							0 Hz
6 7	$\pm \pm$											
8 9 10												
11										>	2	
MSG.				_				STATUS			1	



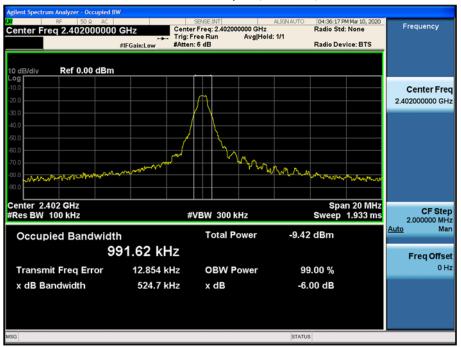


9.2 6dB BANDWIDTH

Mode (Bit/s)	Channel	6 dB Bandwidth (kHz)	Limit (kHz)
	0	524.7	
1M	19	510.8	> 500
	39	519.7	
	0	819.1	
2M	19	852.8	> 500
	39	808.2	

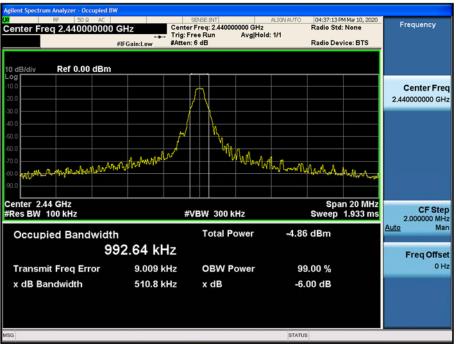


IM Bit/s (255 Byte) Test Plots



6 dB Bandwidth plot (Low-CH 0)

6 dB Bandwidth plot (Mid-CH 19)





Agilent Spectrum Analyzer - Occupied BW		SENSE:INT	ALIGNAUTO 04:37:31 P	M Mar 10, 2020	
Center Freq 2.48000000 G	Trig:	ter Freq: 2.480000000 GHz Free Run Avg Hold en: 6 dB	Radio Std : 1/1 Radio Dev		Frequency
10 dB/div Ref 0.00 dBm					
-10.0 -20.0 -30.0					Center Freq 2.480000000 GHz
-40.0 -50.0 -60.0	h a ch				
-70 0 -00 0 John Marked Marked Marked	hardwaland a	- Yalla	Munu	hardan	
Center 2.48 GHz #Res BW 100 kHz		#VBW 300 kHz		n 20 MHz 1.933 ms	CF Step 2.000000 MHz
Occupied Bandwidth		Total Power	-4.49 dBm		<u>Auto</u> Man
99	2.71 kHz				Freq Offset
Transmit Freq Error	12.473 kHz	OBW Power	99.00 %		0 Hz
x dB Bandwidth	519.7 kHz	x dB	-6.00 dB		
MSG			STATUS		

6 dB Bandwidth plot (High-CH 39)



2M Bit/s (255 Byte) Test Plots

Agilent Spectrum Analyzer - Occupied B					
Center Freq 2.40200000	GHz Cent	SENSE:INT er Freq: 2.402000000 GH: Free Run Avg Ho en: 10 dB	z old: 1/1	Adio Std: None Radio Device: BTS	Frequency
Ref Offset 10.47 of 10 dB/div Ref 15.00 dBn					
5.00					Center Free 2.402000000 GH
25.0			han		
45.0					
55.0					
Center 2.402 GHz Res BW 100 kHz		#VBW 300 kHz		Span 5 MHz Sweep 2.533 ms	CF Ster 500.000 kH
Occupied Bandwidt	'n	Total Power	6.48	dBm	Auto Ma
1.	8309 MHz				Freq Offse
Transmit Freq Error	12.661 kHz	OBW Power	99.	.00 %	0 H
x dB Bandwidth	819.1 kHz	x dB	-6.0	00 dB	
3 <mark>6</mark>			STATUS		

6 dB Bandwidth plot (Low-CH 0)

6 dB Bandwidth plot (Mid-CH 19)





Agilent Spectrum An	alyzer - Occupied BV	N	SENSE:INT		ALIGNAUTO	11/02/40 /	AM Feb 19, 2020		-
	2.480000000	GHz #IFGain:Low	Center Freq: 2.480 Trig: Free Run #Atten: 10 dB	000000 GHz Avg Hole		Radio Sto	: None	Fre	equency
10 dB/div	Ref Offset 10.47 d Ref 15.00 dBm								
Log 5.00 -5.00									enter Freq 000000 GHz
-25.0	\sim					<u></u>	~		
-45.0 -55.0 -65.0									
Center 2.48 G #Res BW 100			#VBW 300	kHz			oan 5 MHz 2.533 ms		CF Step 500.000 kHz
Occupied	l Bandwidti	h 8888 MH		Power	6.87	dBm		<u>Auto</u>	Man
Transmit F x dB Band	req Error	20.218 ki 808.2 ki	Hz OBW	Power		.00 % 00 dB		F	Freq Offset 0 Hz
MSG					STATUS				

6 dB Bandwidth plot (High-CH 39)



9.3 OUTPUT POWER

Peak Power

Data rate	Packet length	LEM	lode	Measured	Limit	
(Bit/s)	(Byte)	Frequency [MHz]	Channel	Power(dBm)	(dBm)	
		2402	0	-0.812		
	37	2440	19	-0.568		
1M		2480	39	-0.383		
TIM		2402	0	-0.844		
	255	2440	19	-0.567	20	
		2480	39	-0.380		
		2402	0	-0.759	- 30	
	37	2440	19	-0.511		
214		2480	39	-0.324		
2M		2402	0	-0.752		
	255	2440	19	-0.505		
		2480	39	-0.313		



Average Power

Data rate	Packet length	LE Mode		Measured Power	Duty Cycle Factor	Result	Limit (dBm	
(Bit/s)	(Byte)	Frequency [MHz]	Channel	(dBm)	(dB)	(dBm))	
		2402	0	-2.15	1.23	-0.92		
	37	2440	19	-1.87	1.23	-0.64		
114		2480	39	-1.78	1.23	-0.56	-	
1M	255	2402	0	-1.19	0.24	-0.95		
		2440	19	-0.87	0.24	-0.63		
		2480	39	-0.67	0.24	-0.43		
	37	2402	0	-3.04	2.12	-0.92	30	
		2440	19	-2.76	2.12	-0.65	-	
214		2480	39	-2.72	2.12	-0.61		
2M	255	2402	0	-1.40	0.46	-0.94		
		2440	19	-1.13	0.46	-0.67		
		2480	39	-0.88	0.46	-0.42		

Note :

1. Power meter offset = Attenuator loss + Cable loss

2. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB.

So, 10.47 dB is offset for 2.4 GHz Band.



9.4 POWER SPECTRAL DENSITY

Fraguanay			Test Result			
Frequency (MHz)	Channel No.	Mode	Measured	Limit		
(Power(dBm)	(dBm)		
2402	0		-11.760			
2440	19	1M 255 Byte	-9.269			
2480	39		-11.484	8		
2402	0		-14.423	8		
2440	19	2M 255 Byte	-14.548			
2480	39		-13.779			

Note :

1. Spectrum reading values are not plot data.

The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.

- 2. Spectrum offset = Attenuator loss + Cable loss
- 3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB.

So, 10.47 dB is offset for 2.4 GHz Band.



IM Bit/s (255 Byte) Test Plots



Power Spectral Density (Low-CH 0)

Power Spectral Density (Mid-CH 19)





Center F	RF 50 Ω AC req 2.48000000) GHz	SENSE:INT	ALIGNAUTO #Avg Type: RMS	TRACE 1 2 3 4 5 6	Frequency
		PNO: Close ++ IFGain:Low	Trig: Free Run Atten: 6 dB	Avg Hold: 1/1	DET PPPPP	
10 dB/div	Ref Offset 10.47 dB Ref 5.00 dBm			Mkr1	2.479 977 4 GHz -11.484 dBm	Auto Tune
-5.00			↓1			Center Fred 2.480000000 GH;
-15.0	Waygamana	Morent	wayahan	MAN WAR	hummunu	Start Fred 2.479630561 GH;
-35.0						Stop Free 2.480369439 GH
-65.0						CF Ster 73.888 kH <u>Auto</u> Ma
-75,0						Freq Offse 0 H
	4800000 GHz				Span 738.9 kHz	
#Res BW	3.0 KHz	#VBW	9.1 kHz	Sweep	78.45 ms (1000 pts)	

Power Spectral Density (High-CH 39)



2M Bit/s (255 Byte) Test Plots



Power Spectral Density (Low-CH 0)

Power Spectral Density (Mid-CH 19)





	RF 50 Ω AC req 2.480000000) GHz	SENSE:INT	ALIGN AUTO #Avg Type: RMS	11:24:48 AM Feb 19, 2020 TRACE 2 3 4 5 6	Frequency
		PNO: Wide ++ IFGain:Low	. Trig: Free Run Atten: 6 dB	Avg Hold: 1/1	DET PPPPP	
10 dB/div	Ref Offset 10.47 dB Ref 5.00 dBm			Mkr1 3	2.480 060 1 GHz -13.779 dBm	Auto Tune
-5.00						Center Free
			∮ ¹			2.480000000 GH
-15.0	. MA	mmmmm	har work was	1 hour hour	Man	Start Free 2.479393866 GH
-25.0	UNA ANNY		¥	1. 1. 1	MM MM	2.473333000 311
-35.0						Stop Free 2.480606134 GH
-45.0						
-55.0						CF Stej 121.227 kH Auto Mai
-65.0						
-75,0						Freq Offse 0 H
85,0						
	4800000 GHz				Span 1.212 MHz	
#Res BW	3.0 kHz	#VBW	9.1 kHz	Sweep	128.7 ms (1000 pts)	

Power Spectral Density (High-CH 39)





9.5 BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

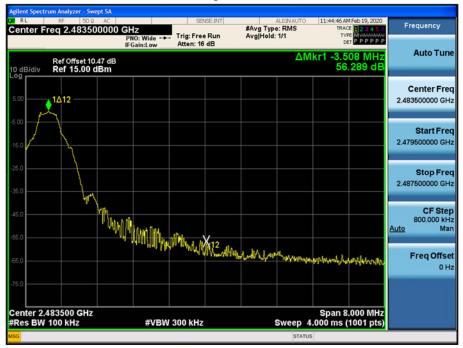
Test Result : please refer to the plot below. In order to simplify the report, attached plots were only the worst case channel and data rate.



IM Bit/s (255 Byte) Test Plots -BandEdge



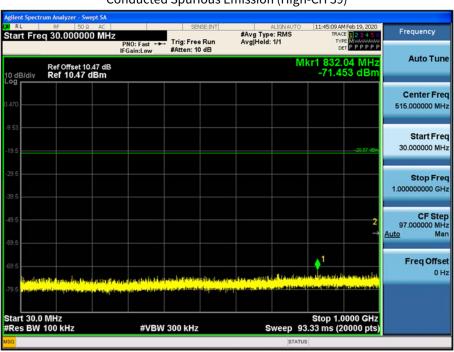
High-CH 39





IM Bit/s (255 Byte) Test Plots -Conducted Spurious Emission

 $30 \text{ MHz} \sim 1 \text{ GHz}$



Conducted Spurious Emission (High-CH 39)

1 GHz ~ 3 GHz

LXU RL	Analyzer - Swept SA RF 50 Ω AC .0000000000		SENSE:INT	ALIGNAUTO #Avg Type: RMS Avg Hold: 1/1	11:44:59 AM Feb 19, 2020 TRACE 12 3 4 5 6 TYPE M	Frequency
10 dB/div R	ef Offset 10.47 d ef 10.47 dBm			Mki	r2 2.608 00 GHz -55.328 dBm	Auto Tune
Log 0.470 -9.53 -19.5				\1 	-20.57.dBm	Center Freq 2.000000000 GHz
-29.5 -39.5 -49.5					¢ ²	Start Freq 1.00000000 GHz
-59.5 -69.5 -79.5	a daadaa dhar ahbida dhibaata			aller aller aller		Stop Freq 3.000000000 GHz
Start 1.000 0 #Res BW 10		#VBV	V 300 kHz	Sweep 19	Stop 3.000 GHz 92.0 ms (40001 pts)	CF Step 200.000000 MHz
MKR MODE TRC S 1 N 1 1 1 2 N 1 1 1 3 - - - - 4 - - - - 5 - - - -	2	479 85 GHz .608 00 GHz	4 -0.566 dBm -55.328 dBm	FUNCTION FUNCTION WIDTH	FUNCTION VALUE	Auto Man Freq Offset 0 Hz
6 7 8 9 10 11						
MSG				STATU	s	

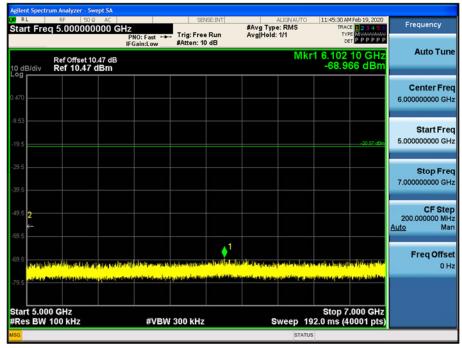


3 GHz ~ 5 GHz



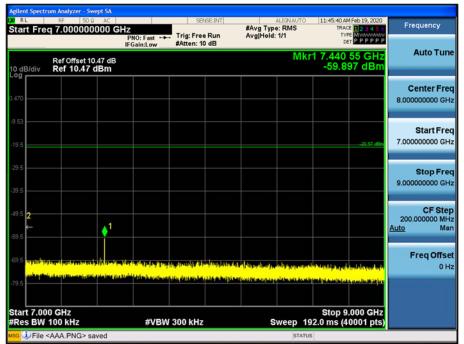
Conducted Spurious Emission (High-CH 39)

5 GHz ~ 7 GHz





7 GHz ~ 9 GHz



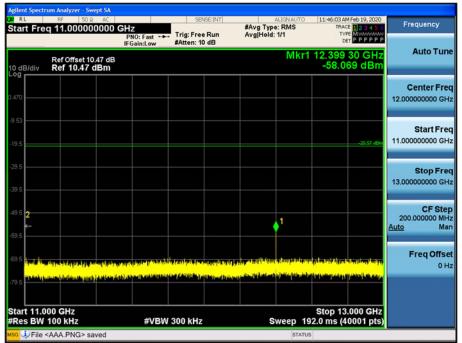
Conducted Spurious Emission (High-CH 39)

9 GHz ~ 11 GHz

Agilent Spectr	um Analyzer - Swept SA RF 50 Ω AC		SENSE:INT		ALIGNAUTO	11:45:50 AM	Feb 19, 2020	
Start Fre	q 9.000000000 (CHZ PNO: Fast ↔	Trig: Free Run	#Avg Type Avg Hold:		TRACE	123456 M	Frequency
		IFGain:Low	#Atten: 10 dB					Auto Tune
10 dB/div	Ref Offset 10.47 dB Ref 10.47 dBm	,			IVIKET	10.869 -68.54	1 dBm	
209								Center Free
3.470								10.00000000 GH
.9.53								
							-20.57 dBm	Start Free 9.000000000 GH
19.5							-20.57 0011	
29.5								Stop Free
39.5								11.00000000 GH
								CF Ster
49.5 2								200.000000 MH Auto Mar
69.5							_	Auto Mar
69.5							• ¹	Freq Offse
iter Hat	with the first of the state of the							0 H:
79,5 veltoritat	el a completion in terrar local de la	ulotta liking and talk a	ALCOLOGY STRUCTURE			Longerere		
Start 9.00						Stop 44		
Res BW		#VBW	300 kHz	s	weep 19	Stop 11. 2.0 ms (40	000 GH2 0001 pts)	
Isa 🧼 File 🔹	<aaa.png> saved</aaa.png>				STATUS	5		



11 GHz ~ 13 GHz



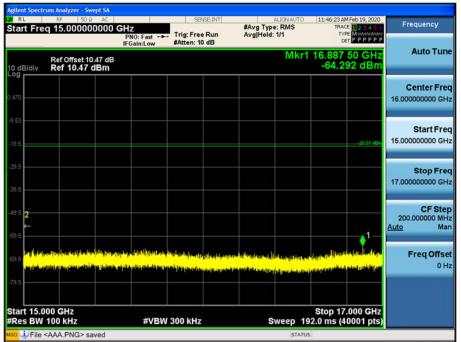
Conducted Spurious Emission (High-CH 39)

13 GHz ~ 15 GHz

Start Freq 13.	50 R AC	Hz PNO: Fast ↔	, Trig: Free		#Avg Type Avg Hold:		TRA	M Feb 19, 2020 CE 1 2 3 4 5 6 PE MULTINE ET P P P P P P P	Frequency
10 dB/div Ref	Offset 10.47 dB 10.47 dBm	IFGain:Low	#Atten: 10	dB		Mkr1	14.891	55 GHz 32 dBm	Auto Tun
.470									Center Fre 14.000000000 GH
9.53								-20.57 cBm	Start Fre 13.000000000 GF
29.5									Stop Fre 15.00000000 GH
19.5 <mark>2</mark>									CF Ste 200.000000 Mi <u>Auto</u> M
59,5 59,5 <mark>119,119,19,19,19,19,19,19</mark>	a ji a kala da	unica lista estas	sejil an rezinezi n	ana ta sarahi	digit biti basari Ang sang san		a na participa di Anti-contropor	n ha kili antak n ha kili antak	Freq Offs
79.5			A STREET OF COMPANY						
tart 13.000 G Res BW 100 I		#VBV	/ 300 kHz		s	weep 19		.000 GHz 0001 pts)	

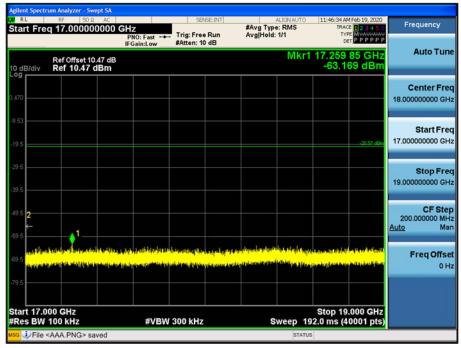


15 GHz ~ 17 GHz



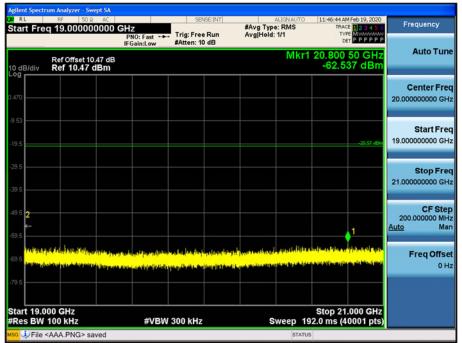
Conducted Spurious Emission (High-CH 39)

17 GHz ~ 19 GHz



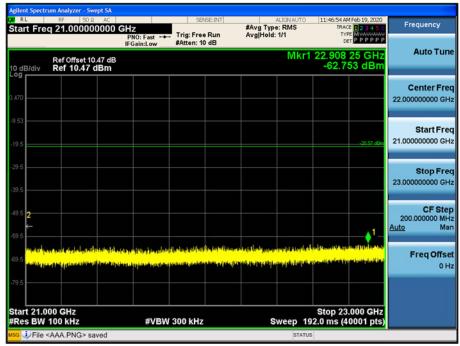


19 GHz ~ 21 GHz



Conducted Spurious Emission (High-CH 39)

21 GHz ~ 23 GHz





23 GHz ~ 25 GHz

a RL Start Fre	RF 50 Ω AC q 23.000000000		SENSE:INT	#Avg Type: RMS Avg Hold: 1/1	TO 11:47:05 AM Feb 19, 2020 TRACE 2 3 4 5 6 TYPE M	Frequency
0 dB/div	Ref Offset 10.47 d Ref 10.47 dBm		#Atten: 10 dB		r1 24.143 95 GHz -56.957 dBm	Auto Tune
470						Center Free 24.000000000 GH
9.53					-20.57.6Bm	Start Free 23.000000000 GH
39.5						Stop Free 25.000000000 GH
9.5 <mark>2</mark>		saadal all bi or a seka	an tree spite in star at the spite of	1	u her availa seks kitakoo didaalaa	CF Step 200.000000 MH <u>Auto</u> Ma
9.5 	and a support of the support of the support		a suttine of all of a lower and	<mark>ta di una té da kanja pina Kolka</mark>	<mark>lover of a stand of a</mark>	Freq Offse 0 H
tart 23.0	00 GHz 100 kHz	#VBW	300 kHz	Sween	Stop 25.000 GHz 192.0 ms (40001 pts)	



2M Bit/s (255 Byte) Test Plots -BandEdge



High-CH 39

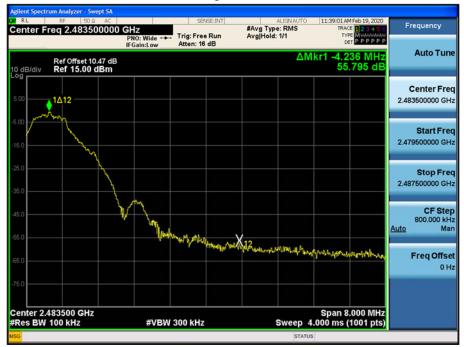
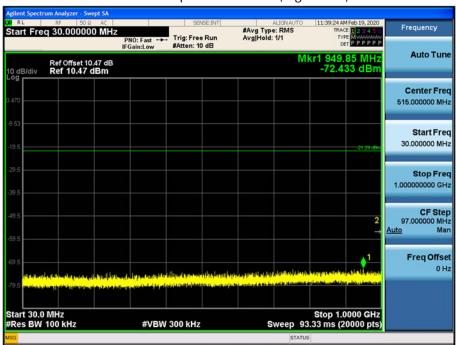




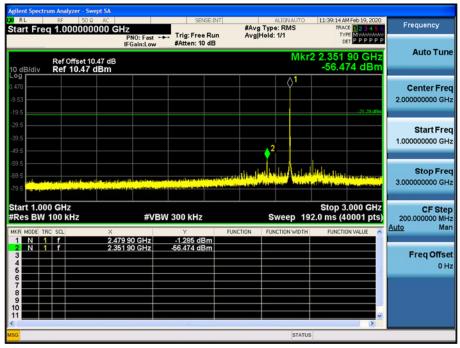
Image: Second Second

 $30 \text{ MHz} \sim 1 \text{ GHz}$



Conducted Spurious Emission (High-CH 39)

1 GHz ~ 3 GHz



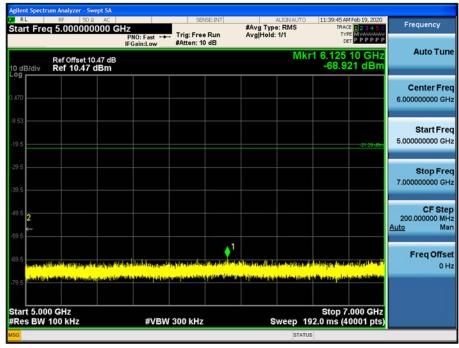


3 GHz ~ 5 GHz



Conducted Spurious Emission (High-CH 39)

5 GHz ~ 7 GHz



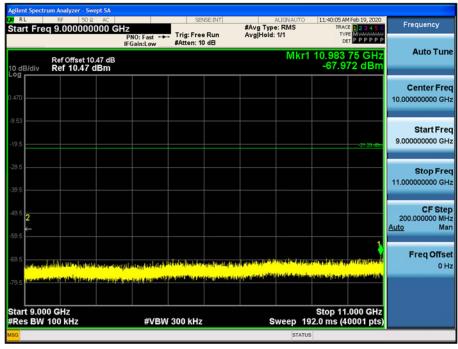


7 GHz ~ 9 GHz



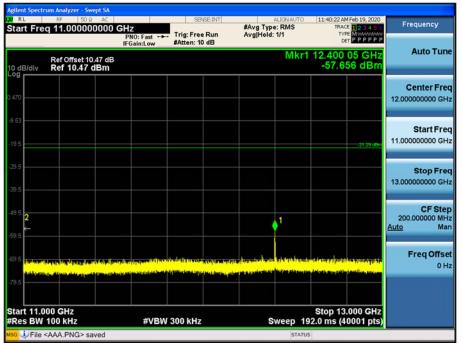
Conducted Spurious Emission (High-CH 39)

9 GHz ~ 11 GHz





11 GHz ~ 13 GHz



Conducted Spurious Emission (High-CH 39)

13 GHz ~ 15 GHz

