

# FCC / ISED BT LE REPORT

Certification

Date of Issue: Applicant Name: December 08, 2017 WISOL CO., LTD Test Site/Location: HCT CO., LTD., 74, Seoicheon-ro 578beon-gil, Majangmyeo, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA Address: 531-7, Gajang-ro, Osan-si Gyeonggi-do, 18103, Korea Report No.: HCT-R-1712-F003 ISED Registration Number: 5944A-5 FCC ID : 2ABA2SFM60R2 IC : 11534A-SFM60R2 APPLICANT : WISOL CO., LTD According to the Evaluation report, all of the data contained herein is reused from the reference

FCC ID : 2ABA2SFM20R2 / IC ID : 11534A-SFM20R2 report.

[Exceptions : The radiated test was fully test.]

Model:	SFM60R2
EUT Type:	Sigfox/BLE/GPS module
<b>RF Peak Output Power:</b>	3.253 dBm (2.12 mW)
Frequency Range:	2402 MHz -2480 MHz
Modulation type	GFSK
FCC Classification:	Digital Transmission System(DTS)
FCC Rule Part(s):	Part 15.247
ISED Rule Part(s):	RSS-247 Issue 2 (February 2017), RSS-Gen Issue 4(November 2014)

Engineering Statement:

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

HCT CO., LTD. Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998,21 U.S. C.853(a)

Report prepared by : Se Wook Park Engineer of Telecommunication testing center

Approved by : Jong Seok Lee Manager of Telecommunication testing center

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HCT CO., LTD.



# **Version**

TEST REPORT NO.	DATE	DESCRIPTION
HCT-R-1712-F003	December 08, 2017	- First Approval Report



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# **1. GENERAL INFORMATION**

Applicant:	WISOL CO., LTD				
Address:	531-7, Gajang-ro, Osan-si Gyeonggi-do, 18103, Korea				
FCC ID:	2ABA2SFM60R2				
IC	11534A-SFM60R2				
EUT Type:	Sigfox/BLE/GPS module				
Model:	SFM60R2				
Date(s) of Tests:	October 10, 2017 ~ December 05, 2017				
Place of Tests:	HCT Co., Ltd.				
	74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea				

Model	SFM60R2				
EUT Type	Sigfox/BL	E/GPS module			
Power Supply	DC 3.3 V				
Frequency Range	TX: 2402 MHz ~ 2480 MHz RX: 2402 MHz ~ 2480 MHz				
	Peak	3.253 dBm (2.12 mW)			
Max. RF Output Power	Average	3.180 dBm (2.08 mW)			
BT Operating Mode	BT_Low	Energy Mode			
Modulation Type	GFSK				
Number of Channels	40 Channels				
	Manufacturer: INNO-LINK				
Antenna Specification	Antenna type: External dipole antenna				
Peak Gain : 4.44 dBi					

# **2. EUT DESCRIPTION**



# **3. TEST METHODOLOGY**

FCC KDB 558074 D01 DTS Meas Guidance v04 dated April 5, 2017 entitled "Guidance for Performing Compliance Measurements on Digital Transmission Systems(DTS) and the measurement procedure described in ANSI C63.10(Version : 2013) 'the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices'.

# **3.1 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.

# 3.2 EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose 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 / RSS-Gen issue 4, RSS-247 issue 2.

# 3.3 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 8 of ANSI C63.10. (Version: 2013)

# **Conducted Antenna Terminal**

See Section from 9.1 to 9.2.(KDB 558074 v04)

# 3.4 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.

Channel low, mid and high with highest data rate (worst case) is chosen for full testing.



# 4. 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 equipments, which is traceable to recognized national standards.

Espectially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2006).

# **5. FACILITIES AND ACCREDITATIONS**

# 5.1 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, 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 July 07, 2015 (Registration Number: 90661)

# 5.2 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."

# 6. ANTENNA REQUIREMENTS

# According to FCC 47 CFR §15.203 / RSS-Gen(Issue 4) Section 8.3:

"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."

\*This module has SMA type antenna connector, not unique coupling. So it`s subject to Limited singl e-modular transmitter.

\*The OEM manufacturer who will install this module into their device must not give an access to an tenna and connector by end-user in compliance with FCC Section 15.203.



# 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4:2014.

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

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



# 8. SUMMARY TEST OF RESULTS

# 8.1 FCC Part

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§15.247(a)(2)	> 500 kHz		PASS
Conducted Maximum Peak 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 9.8		PASS
Radiated Spurious Emissions	§15.205, 15.209	cf. Section 9.7.1	RADIATED	PASS
Radiated Restricted Band Edge	§15.247(d), 15.205, 15.209	cf. Section 9.7.2	RADIATED	PASS



# 8.2 ISED Part

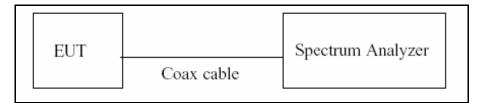
Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	RSS-247, 5.2	> 500 kHz		PASS
99% Bandwidth	RSS-GEN, 6.6	NA		NA
Conducted Maximum Peak Output Power And e.i.r.p.	RSS-247, 5.4.4	< 1 Watt <4 Watt(e.i.r.p.)	CONDUCTED	PASS
Power Spectral Density	RSS-247, 5.2	< 8 dBm / 3 kHz Band		PASS
Band Edge(Out of Band Emissions)	RSS-247, 5.5	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	RSS-GEN, 8.8	RSS-GEN section 8.8 table 3		PASS
Radiated Spurious Emissions	adiated Spurious Emissions RSS-GEN, 8.9			PASS
Receiver Spurious Emissions	RSS-GEN, 5 RSS-GEN, 7.1.2	RSS-GEN section 7.1.2 table 2	RADIATED	PASS
Radiated Restricted Band Edge	RSS-GEN, 8.10	RSS-GEN section 8.10 table 6		PASS



# 9. TEST RESULT 9.1 DUTY CYCLE

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW  $\geq$  OBW if possible; otherwise, set RBW to the largest available value. Set VBW  $\geq$  RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T  $\leq$  16.7 microseconds.)

# **TEST CONFIGURATION**



## TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer. We tested according to the zerospan measurement method, 6.0)b) in KDB 558074 v04.

The largest available value of RBW is 8 MHz and VBW is 50 MHz. The zero-span method of measuring duty cycle shall not be used if  $T \le 6.25$  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 available value)
- 2. VBW = 8 MHz (≥ 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 = 10\*log(1/Duty Cycle)

LE Mode	T <sub>on</sub> (ms)	T <sub>total</sub> (ms)	Duty Cycle	Duty Cycle Factor (dB)
	0.3939	0.6257	0.6295	2.01



# RESULT PLOTS

1000       1 <th>Frequency</th> <th>4 Jun 08, 2017</th> <th>TRACE</th> <th></th> <th>ALIGN A ype: Pwr(</th> <th>#Avg</th> <th></th> <th>ENSE:I</th> <th></th> <th></th> <th>GHz</th> <th>AC</th> <th>50 Ω 2.4020</th> <th>RF eq</th> <th>Fre</th> <th>L ter</th>	Frequency	4 Jun 08, 2017	TRACE		ALIGN A ype: Pwr(	#Avg		ENSE:I			GHz	AC	50 Ω 2.4020	RF eq	Fre	L ter
Ref 20.00 dBm       2.84 dB         0 dB/div       Ref 20.00 dBm       2.84 dB         0 dB/div       Ref 20.00 dBm       3Δ4         0 dB/div       Ref 20.00 dBm       2.84 dB         0 dB/div       Ref 20.00 dBm       2.4         1 dA/div       Ref 20.00 dBm       2.4         2 F       1 t       (Δ)       6.21 dB         3 dA/d       1 t       (Δ)       3.3.14 dBm       4         2 F       1 t       (Δ)       3.3.14 dBm       4         3 dA/d       1 t       (Δ) <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>n</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>							n									
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Auto         Y         Function         Function         width         Function         vidth         Function	2.402000000 G															
es BW 8 MHz         #VBW 8.0 MHz         Sweep 1.267 ms (1001 pts)           KR MODE TRC SCL         X         Y         FUNCTION         FUNCTION VIDTH         FUNCTION VALUE           1         Δ2         1         t         (Δ)         393.9 us         (Δ)         6.21 dB         -															_	
KR MODE         TCC SCI         X         Y         FUNCTION         FUNCTION WIDTH         FUNCTION VALUE         Auto           1         Δ2         1         t         (Δ)         393.9 µs         (Δ)         6.21 dB         - <td< td=""><td>CF Ste</td><td>pan 0 Hz (001 pts)</td><td>اS 267 ms (1</td><td>n 1.2</td><td>Swee</td><td></td><td></td><td>7</td><td>8.0 MHz</td><td>VBW</td><td>#\</td><td>Hz</td><td></td><td></td><td></td><td></td></td<>	CF Ste	pan 0 Hz (001 pts)	اS 267 ms (1	n 1.2	Swee			7	8.0 MHz	VBW	#\	Hz				
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3         Δ4         1         t         (Δ)         625.7 μs         (Δ)         2.84 dB           4         F         1         t         329.3 μs         -3.14 dBm           5         5         5         5         5         5           6         7         8         6         6         6         6         6         7         8         7         8         7         8         7         8         9	<u></u>		10110110		, one note		101		6.21			2.4			1	
	Freq Offs							4 dB	2.84	s (Δ)	625.7 µs		(Δ)	t	1	Δ4
	01							dBm	-3.14 c	S	329.3 µs			t	1	F



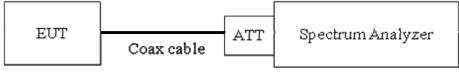
## 9.2 6 dB BANDWIDTH MEASUREMENT

#### Test Requirements and limit, §15.247(a)(2) / RSS-247(Issue 2) Section 5.2.

The bandwidth at 6 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

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 8.1 in KDB 558074 v04)

RBW = 100 kHz VBW  $\geq$  3 x RBW Detector = Peak Trace mode = max hold Sweep = auto couple Allow the trace to stabilize

Note : We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

#### TEST RESULT

Mode	Channel	6 dB Bandwidth	Limit	Pass/Fail	
Mode	Channel	(kHz)	(kHz)	Fass/Faii	
	0	705.2		Pass	
BT LE	19	705.5	> 500	Pass	
	39	704.1		Pass	

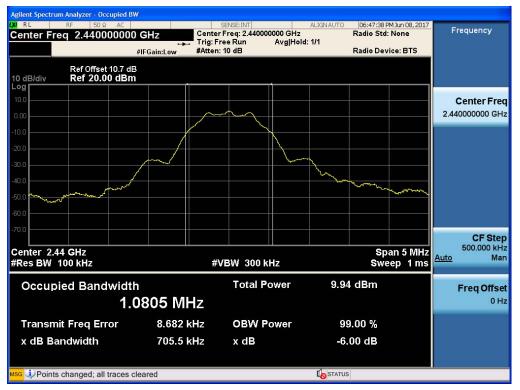


### RESULT PLOTS

gilent Spectrum Analyzer - Occup SENSE:INT Center Freq: 2.402000000 GHz Trig: Free Run Avg|Hol-#Atten: 10 dB ALIGN AUTO 06:14:40 PM Jun 08, 2017 Frequency Radio Std: None Center Freq 2.402000000 GHz Avg|Hold:>1/1 Radio Device: BTS #IFGain:Low Ref Offset 10.7 dB Ref 20.00 dBm 10 dB/div **Center Freq** 2.402000000 GHz CF Step 500.000 kHz Center 2.402 GHz #Res BW 100 kHz Span 5 MHz Auto Man #VBW 300 kHz Sweep 1 ms **Total Power** 9.83 dBm Occupied Bandwidth **Freq Offset** 0 Hz 1.0771 MHz Transmit Freg Error 7.427 kHz **OBW Power** 99.00 % -6.00 dB x dB Bandwidth 705.2 kHz x dB **STATUS** MSG Points changed; all traces cleared

#### 6 dB Bandwidth plot (Low-CH 0)

#### 6 dB Bandwidth plot (Mid-CH 19)









#### 6 dB Bandwidth plot (High-CH 39)

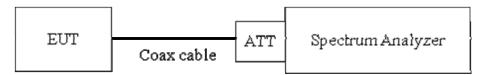


#### 9.3 99% **BANDWIDTH**

#### Limit, RSS-Gen(Issue 4) Section 6.6

The 99 % bandwidth is used to determine the conducted power limits.

## **TEST CONFIGURATION**



## TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer.

RBW = 1% ~ 5% of the occupied bandwidth VBW = 3 x RBW Detector = Peak Trace mode = max hold Sweep = auto couple Allow the trace to stabilize

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

#### TEST RESULTS

#### Conducted 99% Bandwidth Measurements for LE Mode

LE Mode	Measured Bandwidth		
Frequency [MHz]	Channel No.	[MHz]	
2402	0	1.0549	
2440	19	1.0596	
2480	39	1.0614	



### RESULT PLOTS

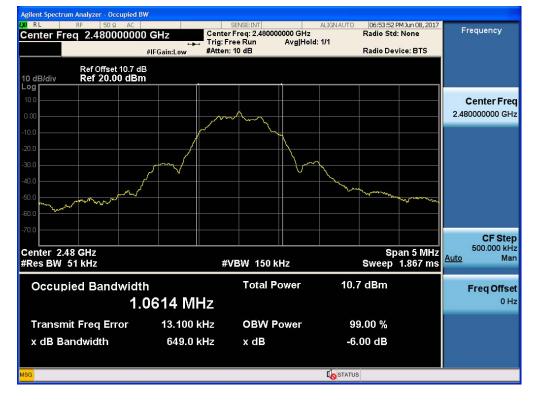


#### 99% Bandwidth plot (Low-CH 0)

#### 99% Bandwidth plot (Mid-CH 19)







## 99% Bandwidth plot (High-CH 39)



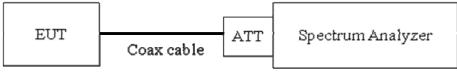
# 9.4 OUTPUT POWER MEASUREMENT

#### Test Requirements and limit, §15.247(b)(3) / RSS-247(Issue2) Section 5.4.4.

A transmitter antenna terminal of EUT is connected to the input of a Spectrum Analyzer. Measurement is made while the EUT is operating in transmission mode at the appropriate frequencies.

The maximum permissible conducted output power is 1 Watt.

#### **TEST CONFIGURATION**



#### TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer. We use the spectrum analyzer's integrated band power measurement function.

This EUT TX condition is actual operating mode by BT LE mode test program.

#### The Spectrum Analyzer is set to

```
    Peak Power (Procedure 9.1.1 in KDB 558074 v04)
```

RBW ≥ DTS Bandwidth

- VBW ≥ 3 x RBW
- SPAN ≥ 3 x RBW

Detector Mode = Peak

Sweep = auto couple

Trace Mode = max hold

Allow trace to fully stabilize.

Use peak marker function to determine the peak amplitude level

Average Power (Procedure 9.2.2.4 in KDB 558074 v04)

Measure the duty cycle

Set span to at least 1.5 times the OBW

RBW = 1-5 % of the OBW, not to exceed 1 MHz.

VBW  $\geq$  3 x RBW.

Number of points in sweep  $\ge 2 \times \text{span} / \text{RBW}$ . (This gives bin-to-bin spacing  $\le \text{RBW}/2$ ,

so that narrowband signals are not lost between frequency bins.)

Sweep time = auto.

Detector = RMS(i.e., power averaging)

Do not use sweep triggering. Allow the sweep to "free run".

Trace average at least 100 traces in power averaging(RMS) mode.

Compute power by integrating the spectrum across the OBW of the signal using the instrument's band



power measurement function with band limits set equal to the OBW band edges. 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

Output Power = Reading Value + ATT loss + Cable loss(1 ea) + Duty Cycle Factor Output Power = 10 dBm + 10 dB + 0.8 dB + 0.2 dB = 21.0 dBm

Note :

- 1. Spectrum reading values are not plot data. The power 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, 10.7 dB is offset for 2.4 GHz Band.



## TEST RESULTS-Peak

#### Conducted Output Power Measurements

LE Me	ode	Measured	Limit	
Frequency[MHz]	Channel No.	Power(dBm)	(dBm)	
2402	0	3.069	30	
2440	19	3.142	30	
2480	39	3.253	30	

#### TEST RESULTS-Average

#### **Conducted Output Power Measurements**

LE Mode			Duty Cycle	Measured		
Frequency[MHz]	Channel No.	Measured Power(dBm)	Duty Cycle Factor (dB)	Power(dBm) + Duty Cycle Factor(dB)	Limit (dBm)	
2402	0	0.85	2.01	2.86	30	
2440	19	1.02	2.01	3.03	30	
2480	39	1.17	2.01	3.18	30	



#### RESULT PLOTS-Peak



# Conducted Output Power (Mid-CH 19)

RL RF 50 Ω AC Center Freq 2.4400000	00 GHz	#Avg Type: Pwr(RMS)	59 PM Jun 08, 2017 TRACE 12 3 4 5 6 TYPE M WAAMAAAAA
	PNO: Fast ↔ Trig: Free Ri IFGain:Low Atten: 20 d⊟		
Ref Offset 10.7 dE 0 dB/div Ref 20.00 dBm	3		.142 dBm
			Center Fre
10.0	1		2.440000000 GH
3.00			Start Fre
10.0			2.438500000 GH
20.0			
30.0			2.441500000 GF
0.0			CF Ste 300.000 kl
50.0			Auto Ma
50.0			FreqOffs
0.0			01
0.0			
enter 2.440000 GHz	#\/D\\/ 2.0 MU-	Spar Swoon 1 97 m	n 3.000 MHz
Res BW 1.0 MHz	#VBW 3.0 MHz	Sweep 1.07 m	



Agilent Spectrum Analyzer - Swept SA		SENSE:INT	ALIGNAUTO	06:54:01 PM Jun 08, 2017	
Center Freq 2.48000000	0 GHz		#Avg Type: Pwr(RMS) Avg Hold: 1/1	TRACE 123456	Frequency
Ref Offset 10.7 dB 10 dB/div Ref 20.00 dBm	IFGain:Low	Atten: 20 dB	Mkr1	2.479 737 GHz 3.253 dBm	Auto Tune
10.0		<b>♦</b> <sup>1</sup>			Center Fred 2.480000000 GHz
0.00					Start Free 2.478500000 GH
30.0					<b>Stop Fre</b> 2.481500000 GH
40.0					CF Ste 300.000 kH <u>Auto</u> Ma
50.0					Freq Offse 0 H
70.0 Center 2.480000 GHz Res BW 1.0 MHz	#VBW	/ 3.0 MHz	Sweep	Span 3.000 MHz 1.07 ms (1000 pts)	
se iPoints changed; all traces			STATUS		

# Conducted Output Power (High-CH 39)

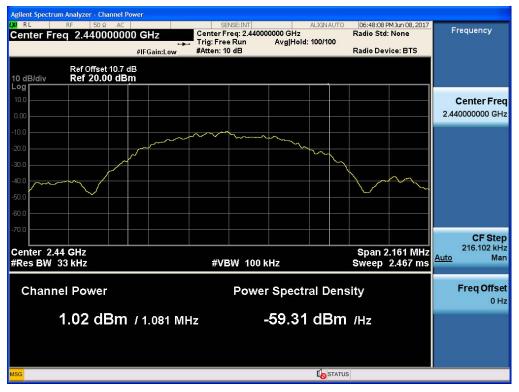


#### RESULT PLOTS-Average

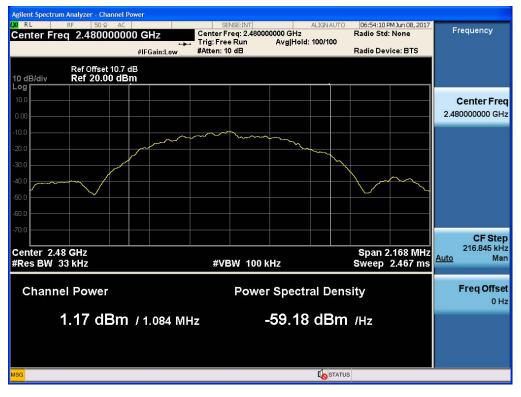


# Conducted Output Power (Low-CH 0)

#### **Conducted Output Power (Mid-CH 19)**







## **Conducted Output Power (High-CH 39)**



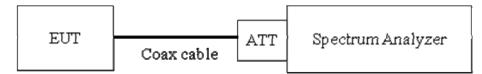
# 9.5 POWER SPECTRAL DENSITY

#### Test Requirements and limit, §15.247(e) / RSS-247(Issue 2) Section 5.2.

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

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

#### **TEST CONFIGURATION**



#### TEST PROCEDURE

We tested according to Procedure 10.2 in KDB 558074, issued 04/05/2017

The spectrum analyzer is set to :

Set analyzer center frequency to DTS channel center frequency.

Span = 1.5 times the DTS channel bandwidth.

 $RBW = 3 kHz \le RBW \le 100 kHz.$ 

VBW  $\geq$  3 x RBW.

Sweep = auto couple

Detector = peak

Trace Mode = max hold

Allow trace to fully stabilize.

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

PSD = Reading Value + ATT loss + Cable loss(1 ea) Output Power = -5 dBm + 10 dB + 0.8 dB = 5.8 dBm 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,10.7 dB is offset for 2.4 GHz Band.

#### TEST RESULTS

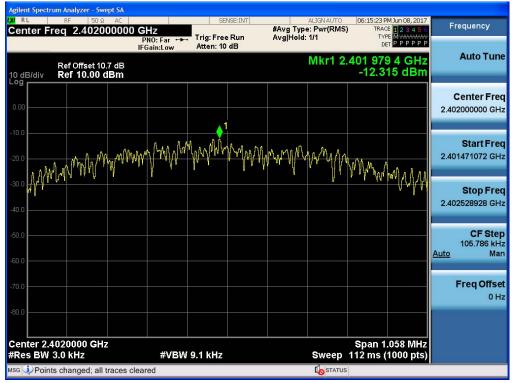


### **Conducted Power Density Measurements**

Frequency Channe	Channel		Test Result					
Frequency (MHz)	(MHz) No.	5	Mode	PSD	Limit	Pass/		
(11112)			(dBm)	(dBm)	Fail			
2402	0		-12.315	8	Pass			
2440	19	LE	-12.177	8	Pass			
2480	39		-12.143	8	Pass			

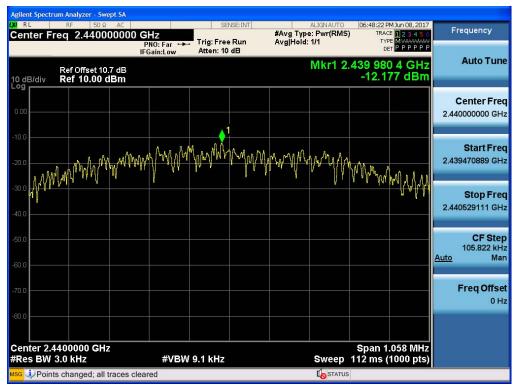


### RESULT PLOTS



# Power Spectral Density (Low-CH 0)

# Power Spectral Density (Mid-CH 19)







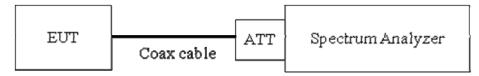
# **Power Spectral Density (High-CH 39)**



# 9.6 OUT OF BAND EMISSIONS AT THE BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS Test Requirements and limit, §15.247(d) / RSS-247(Issue 2) Section 5.5.

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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.205(c)).

# Limit : 20 dBc



# TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. (Procedure 11.0 in KDB 558074, issued 04/05/2017)

RBW = 100 kHz

VBW ≥ 3 x RBW

Set span to encompass the spectrum to be examined

Detector = Peak

Trace Mode = max hold

Sweep time = auto couple

Ensure that the number of measurement points  $\geq$  2\*Span/RBW

Allow trace to fully stabilize.

Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 10<sup>th</sup> harmonic range with the transmitter set to the lowest, middle, and highest channels.

Note :

1. The maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1(KDB558074 v04), so the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).



- 2. The band edge results in plot is already including the actual values of loss for the attenuator and cable combination.
- 3. Spectrum offset = Attenuator loss + Cable loss
- 4. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 10.7 dB is offset for 2.4 GHz Band.
- 5. In case of conducted spurious emissions test, please check factors blow table.
- 6. In order to simplify the report, attached plots were only the worst case channel and data rate.

Freq(MHz)	Factor(dB)
30	11.30
100	9.83
200	10.19
300	10.13
400	10.23
500	10.25
600	10.32
700	10.35
800	10.35
900	10.34
1000	10.39
2000	10.64
2400*	10.65
2500*	10.67
3000	10.68
4000	10.89
5000	11.07
6000	11.06
7000	11.35
8000	11.32
9000	11.48
10000	11.56
11000	11.56
12000	11.68
13000	11.83
14000	11.90
15000	11.98
16000	12.04

# **FACTORS FOR FREQUENCY**



#### Report No.: HCT-R-1712-F003

12.02
12.08
12.07
12.14
12.17
12.31
12.60
12.34
12.53

Note : 1. '\*' is fundamental frequency range.

2. Factor = Cable loss + Attenuator loss

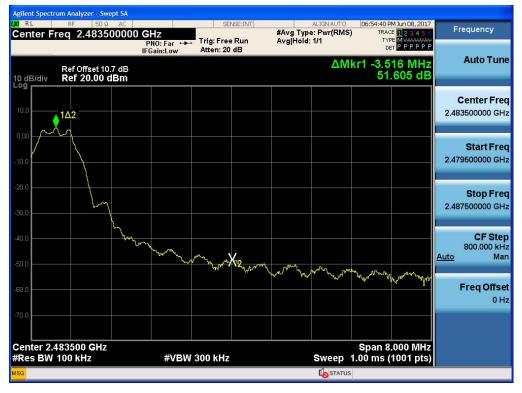


### RESULT PLOTS



#### BandEdge (Low-CH 0)

# BandEdge (High-CH 39)



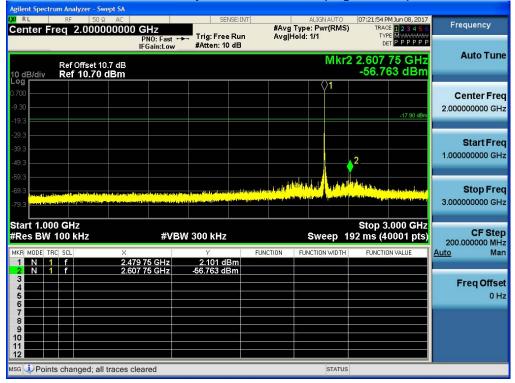


#### 30 MHz ~ 1 GHz

nt Spectrum Anal OW RL RF 500 MHz Center Freq 515.000000 MHz PN0:Fast ↔ IFGain:Low RL :04 PM Jun 08, 2017 Frequency TRACE 123456 TYPE MWWWWW DET PPPPP #Avg Type: Pwr(RMS) Avg|Hold: 1/1 Trig: Free Run #Atten: 10 dB Auto Tune Mkr1 836.93 MHz -63.132 dBm Ref Offset 10.7 dB Ref 10.70 dBm 10 dB/div **Center Freq** 515.000000 MHz Start Freq -17.90 dB 30.000000 MHz Stop Freq 1.000000000 GHz CF Step 97.000000 MHz 2 Man Auto 1 **Freq Offset** والنام المظاهر وخاصاء أوياكه فكالحارية ليقرأ وكالمو ويالوه ومحاويا ويتقافه أستسبع A.L. M. M. M. B. M. 0 Hz ter pildy from stor behavior, more alle pildy Stop 1.0000 GHz Sweep 93.3 ms (20000 pts) Start 30.0 MHz #Res BW 100 kHz #VBW 300 kHz MSG Deints changed; all traces cleared

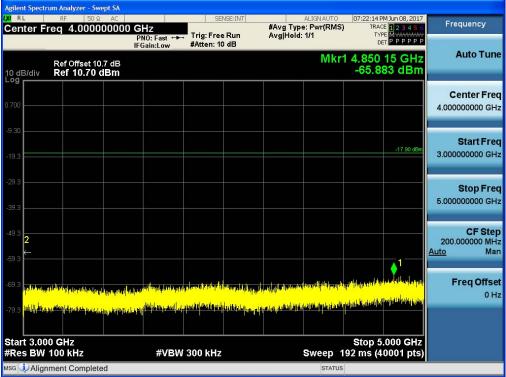
# **Conducted Spurious Emission (High-CH 39)**

#### 1 GHz ~ 3 GHz





#### 3 GHz ~ 5 GHz



# **Conducted Spurious Emission (High-CH 39)**

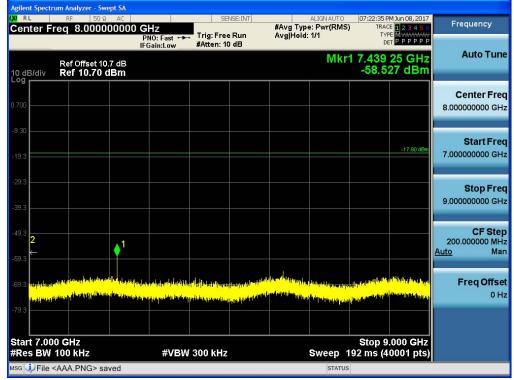
#### 5 GHz ~ 7 GHz



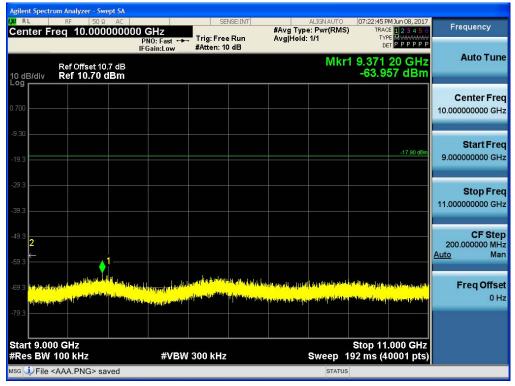


#### 7 GHz ~ 9 GHz

**Conducted Spurious Emission (High-CH 39)** 



#### 9 GHz ~ 11 GHz





# 11 GHz ~ 13 GHz

Agilent Spectr	um Analyzer - Swe	ept SA							ŕ	
LXI RL	RF 50 Ω			SEI	NSE:INT		ALIGN AUTO		1 Jun 08, 2017	Frequency
Center F	req 12.000		) <b>GHZ</b> PNO: Fast ↔→→ IFGain:Low	Trig: Free #Atten: 10		#Avg Typ Avg Hold:	e: Pwr(RMS) : 1/1	TYP	123456 M <del>WWWWW</del> PPPPPP	
10 dB/div Log	Ref Offset 10. Ref 10.70 c						Mkr1	12.401 -62.9	35 GHz 54 dBm	Auto Tune
0.700										Center Freq 12.000000000 GHz
-9.30									-17.90 dBm	Start Freq 11.000000000 GHz
-29.3										<b>Stop Freq</b> 13.00000000 GHz
-49.3 <b>2</b> -59.3							1			CF Step 200.000000 MHz <u>Auto</u> Man
-69.3 <b>tali tan</b> u	n de anticipies de la constante La constante de la constante de la constante La constante de la constante de la constante de la constante de la	litterissisele plite		h dont di la calinat. A statum pictoritan	Hantilalijun.	lighter and the total of the test	a na ini katala. <mark>Na ini katala di kubarana na ini kubarana na ini</mark>	Ballallandara <sup>Cong</sup> ergingan	is latest datations. Press and any second	Freq Offset 0 Hz
-79.3		T ann an In								0112
Start 11.0 #Res BW			#VBW	300 kHz			Sweep 1	Stop 13. 92 ms (40	000 GHz 0001 pts)	
мsg 🧼 File •	<aaa.png> sa</aaa.png>	ved					STATUS			

# Conducted Spurious Emission (High-CH 39)

#### 13 GHz ~ 15 GHz

KI RL	um Analyzer - Swept S           RF         50 Ω         A           reg         14.000000	c	SE	ISE:INT	#Avg Tvp	ALIGNAUTO e: Pwr(RMS)		Jun 08, 2017	Frequency
Senter 1		PNO: Fast ++ IFGain:Low	Trig: Free #Atten: 10		Avg Hold:	1/1	TYPE	M <del>WWWWW</del> PPPPPP	Auto Tun
10 dB/div	Ref Offset 10.7 d Ref 10.70 dBr	B n				IVINII		8 dBm	
.700									Center Free 14.000000000 GH
9.30									
-19.3								-17.90 dBm	Start Free 13.000000000 GH
29.3									
39.3					_				<b>Stop Fre</b> 15.000000000 GH
49.3									CF Ste
* <sup>9.3</sup> <mark>2</mark> 59.3 ←								<b>↓</b> 1	200.000000 MH Auto Ma
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ara <mark>praklika</mark>	nor and to have new				<mark>ge</mark> nglassele <sup>g</sup> sterner	ngaparan dan gerang	ann de la fhalainn de s	and the street.	0F
79.3									
tart 13.0 Res BW		#VBW	300 kHz			Sweep 1	Stop 15.0 92 ms (40	000 GHz 001 pts)	
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### 15 GHz ~ 17 GHz

Agilent Spectr	um Analyzer - Swept SA					
LXI L	RF 50 Ω AC		NSE:INT	ALIGN AUTO		Frequency
Start Fre	q 15.000000000	CHz     PNO: Fast ↔     Trig: Free       IFGain:Low     #Atten: 10	Run	#Avg Type: Pwr(RM: Avg Hold: 1/1	5) TRACE 1 2 3 4 5 5 TYPE MWWWWW DET PPPPP	
10 dB/div Log	Ref Offset 10.7 dB Ref 10.70 dBm			Mkr1	16.396 15 GHz -59.780 dBm	Auto Tune
0.700						Center Freq 16.000000000 GHz
-9.30					-17.90 dBm	Start Freq 15.000000000 GHz
-29.3						Stop Fred 17.000000000 GHz
-49.3 <mark>2</mark> -59.3				1 mit - attration light - Re		CF Step 200.000000 MH Auto Mar
-69.3 <mark>14.10</mark>	i ja kal deli mengeli deli mela edi sa kal deli mengen deli deli mengen deli mengen deli mengen deli mengen de Na mangan tersek ng kanan mengen deli me	A ha the standard for a faile of the first of the standard for the standar			al lateral diselection of the lateral product of the second second	Freq Offset 0 Hz
-79.3 Start 15.0 #Res BW		#VBW 300 kHz		Sween	Stop 17.000 GHz 192 ms (40001 pts)	
ANGS DIV		##BW 300 KHZ		Sweep		

# **Conducted Spurious Emission (High-CH 39)**

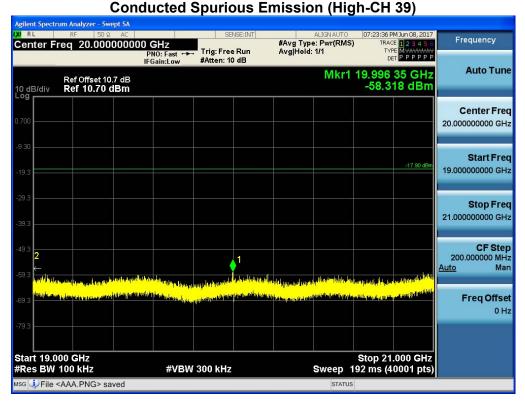
### 17 GHz ~ 19 GHz

# Conducted Spurious Emission (High-CH 39)

		ım Analyzer - 9				0					
Cen			Ω AC	GHz	SE	NSE:INT	#Avg Type	ALIGNAUTO e: Pwr(RMS	) TRAC	M Jun 08, 2017	Frequency
			F	NO: Fast	Trig: Free #Atten: 10		Avg Hold:		DE		Auto Tune
10 dE Log	B/div	Ref Offset Ref 10.70							-59.4	45 GHz 99 dBm	
											Center Freq
0.700										<u>.</u>	18.00000000 GHz
-9.30											
										-17.90 dBm	Start Freq
-19.3											17.000000000 GHz
-29.3											Ctop From
											Stop Freq 19.00000000 GHz
-39.3											
-49.3	2										CF Step
	∠ ←								<b>♦</b> <sup>1</sup>		200.000000 MHz <u>Auto</u> Man
-59.3	udate the day.		الأراديان أولا أحرجني الغذائ	الالبان الماندان ا	ومعاطية أوين فالألغام وا	and the state of the	I. I	Land and and	de the trade of the local	, where had the state	
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			and total a second			11.11	and the second second				0 Hz
-79.3											
Star	+ 17 0	00 GHz							Stop 10	.000 GHz	
		100 kHz		#VBW	300 kHz			Sweep	192 ms (4	0001 pts)	
MSG 🤇	Alignu	ment Comple	eted					STATUS	5		

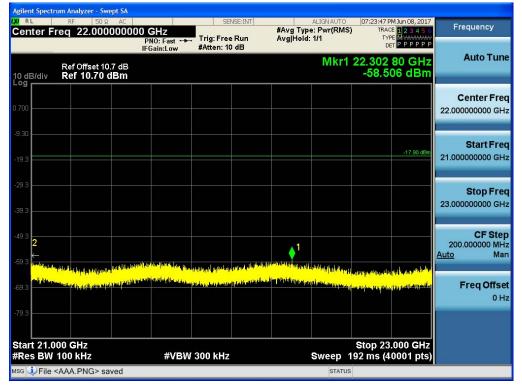


### 19 GHz ~ 21 GHz



# 21 GHz ~ 23 GHz

### Conducted Spurious Emission (High-CH 39)





### 23 GHz ~ 25 GHz

				•						
Agilent Spectr	um Analyzer - Swo	ept SA								
X/ RL		AC		SEI	NSE:INT		ALIGN AUTO	07:23:57 P	4 Jun 08, 2017	
Center F	reg 24.000		GHz			#Avg Typ	e: Pwr(RMS)	TRAC	123456	Frequency
	roq Enooo		NO: Fast	Trig: Free		Avg Hold:	1/1	TYP	M WARAWARANA	
			Gain:Low	#Atten: 10	) dB			DE	T P P P P P P	
							Mkrd	24.477	60 GHZ	Auto Tune
	Ref Offset 10						IVINI I		10 dBm	
10 dB/div	Ref 10.70 d	IBm						-00.04	iu ubili	
										-
										Center Fred
.700			5				2			24.000000000 GHz
										24.0000000000000
9.30										
										Start Free
19.3									-17.90 dBm	23.000000000 GHz
13.3										
29.3							-			
										Stop Freq
										25.00000000 GHz
39.3			-							
49.3										CF Step
2							▲1			200.000000 MHz
←										Auto Man
-59.3	Here, Hable-Level deschalt	n at law this	the second rate	antibent holes have	distants of the l	In Intelligible to be	and the state of the state of the state	مرقلال واجتر ليتقاقه	Last buy lither and blind	
All and the second second	Haller, the de land had also be		and the set of the second		and states	- 19 - 19	Childebulati a La	and south the state	المقادير والم	
-69.3 <mark>2001.00</mark>	ite Bie (b) de joel de station Researce provinse agente in	us de la constituite la	un contradateta	and the second	and the fill of the second second	TRANSFER MILL	1. <b>1</b> 11180	n the frequencies of the second	deployee at a	Freq Offset
-69.3										
										0 Hz
79.3										1
Start 23.0								Stop 25	000 GHz	
			#\/D\4	200 64-			Cureon 4			
#Res BW	TOU KHZ		#VBW	300 kHz			Sweep 1	92 ms (4)	ooo i pis)	
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### **Conducted Spurious Emission (High-CH 39)**



### 9.7 RADIATED MEASUREMENT.

### 9.7.1 RADIATED SPURIOUS EMISSIONS.

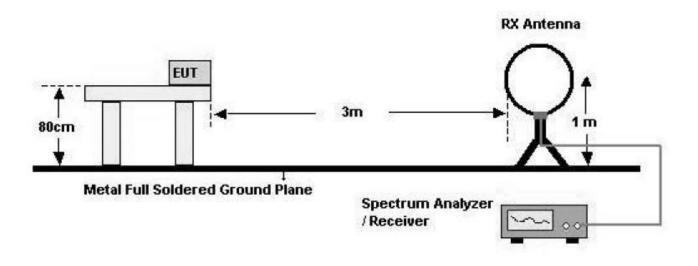
Test Requirements and limit, §15.205, §15.209, RSS-Gen(Issue 4) Section 8.9

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		

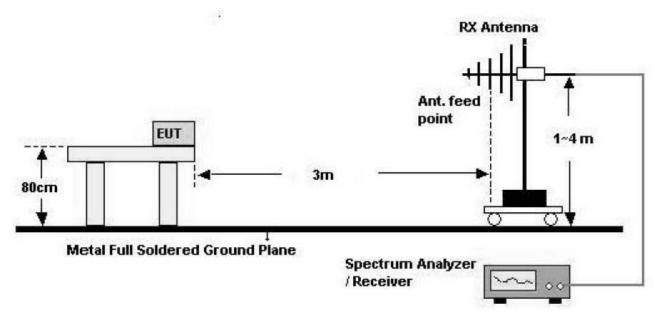


### **Test Configuration**

### Below 30 MHz

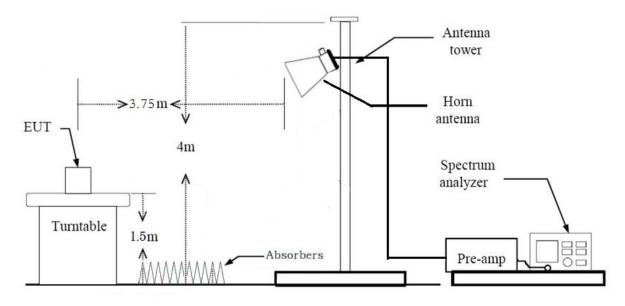


30 MHz - 1 GHz





### Above 1 GHz



### TEST PROCEDURE USED

Method 12.1 in KDB 558074 v04

### Spectrum Setting

- Peak

Peak emission levels are measured by setting the instrument as follows:

RBW = cf. Table 1.

VBW  $\geq$  3 x RBW.

Detector = Peak.

Sweep time = auto.

Trace mode = max hold.

Allow sweeps to continue until the trace stabilizes.

(Note that the required measurement time may be longer for low duty cycle applications).

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

### Table 1 — RBW as a function of frequency

Average (duty cycle < 98%, duty cycle variations are less than ±2%)</li>
Set RBW = 1 MHz
Set VBW ≥ 3 x RBW
Detector = RMS.
Averaging type = power (*i.e.*, RMS).

Sweep time = auto.

Trace mode = average (at least 100 traces).

A 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.

### Note :

1. We are performed the RSE and radiated band edge using standard radiated method(RMS).

2. 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).

nom center of turn table. So, we applied the distance factor (reference distance : 51

3. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)

### Data packet length (Min)

LE Mode	T <sub>on</sub> (ms)	T <sub>total</sub> (ms)	Duty Cycle	Duty Cycle Factor (dB)
	0.3939	0.6257	0.6295	2.01



### TEST RESULTS

### 9 kHz – 30MHz

**Operation Mode:** Normal Mode

Frequency	Reading Ant. factor		Cable loss Ant. POL		Total	Limit	Margin			
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB			
No Critical peaks found										

### Notes:

- 1. Measuring frequencies from 9 kHz to the 30MHz.
- 2. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
- 3. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
- 4. Limit line = specific Limits (dBuV) + Distance extrapolation factor
- 5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
- 6. The test results for below 30 MHz is correlated to an open site.

The result on OATS is about 2 dB higher than semi-anechoic chamber (10 m chamber)



### TEST RESULTS

### Below 1 GHz

### **Operation Mode:** Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin			
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB			
No Critical peaks found										

- 1. Measuring frequencies from 30 MHz to the 1 GHz.
- 2. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
- 3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.



### Above 1 GHz [Antenna 90°]

Operation	Operation Mode: CH.0											
Frequency	Reading	Duty Cycle Factor	A.F.+C.LA.G.+D.F.	ANT. POL	Total	Limit	Margin	Measurement				
[MHz]	[dBuV/m]	[dB]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	Туре				
4804	51.84	0.00	-3.82	V	48.02	73.98	25.96	PK				
4804	41.99	2.01	-3.82	V	40.18	53.98	13.80	AV				
7206	53.47	0.00	-0.12	V	53.35	73.98	20.63	PK				
7206	42.69	2.01	-0.12	V	44.58	53.98	9.40	AV				
4804	52.90	0.00	-3.82	Н	49.08	73.98	24.90	PK				
4804	42.62	2.01	-3.82	Н	40.81	53.98	13.17	AV				
7206	54.31	0.00	-0.12	Н	54.19	73.98	19.79	PK				
7206	43.44	2.01	-0.12	Н	45.33	53.98	8.65	AV				

\*A.F. : Antenna Factor / C.L. : Cable Loss / A.G. : Amplifier Gain / D.F. : Distance Factor

- 1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
- 2. Measurements above show 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.
- 3. Radiated emissions measured in frequency above 1000 MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
- 4. Total = Reading Value + Antenna Factor + Cable Loss Amp Gain + Distance Factor
   + Duty Cycle Factor
- 5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
- 6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.



Frequency	Reading	Duty Cycle Factor	A.F.+C.LA.G.+D.F.	ANT. POL	Total	Limit	Margin	Measurement
[MHz]	[dBuV/m]	[dB]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	Туре
4880	52.61	0.00	-6.12	V	46.49	73.98	27.49	PK
4880	41.91	2.01	-6.12	V	37.8	53.98	16.18	AV
7320	52.84	0.00	-0.27	V	52.57	73.98	21.41	PK
7320	42.67	2.01	-0.27	V	44.41	53.98	9.57	AV
4880	53.57	0.00	-6.12	Н	47.45	73.98	26.53	PK
4880	42.83	2.01	-6.12	Н	38.72	53.98	15.26	AV
7320	53.96	0.00	-0.27	Н	53.69	73.98	20.29	PK
7320	43.16	2.01	-0.27	Н	44.9	53.98	9.08	AV

### Operation Mode: CH.19

- 1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
- 2. Measurements above show 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.
- 3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
- 4. Total = Reading Value + Antenna Factor + Cable Loss Amp Gain + Distance Factor
   + Duty Cycle Factor
- 5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
- 6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.



Frequency	Reading	Duty Cycle Factor	A.F.+C.LA.G.+D.F.	ANT. POL	Total	Limit	Margin	Measurement
[MHz]	[dBuV/m]	[dB]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	Туре
4960	49.81	0.00	-5.54	V	44.27	73.98	29.71	PK
4960	38.99	2.01	-5.54	V	35.46	53.98	18.52	AV
7440	53.84	0.00	0.79	V	54.63	73.98	19.35	PK
7440	39.51	2.01	0.79	V	42.31	53.98	11.67	AV
4960	50.85	0.00	-5.54	Н	45.31	73.98	28.67	PK
4960	39.25	2.01	-5.54	Н	35.72	53.98	18.26	AV
7440	54.93	0.00	0.79	Н	55.72	73.98	18.26	PK
7440	40.63	2.01	0.79	Н	43.43	53.98	10.55	AV

### Operation Mode: CH.39

- 1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
- 2. Measurements above show 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.
- Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
- 4. Total = Reading Value + Antenna Factor + Cable Loss Amp Gain + Distance Factor
   + Duty Cycle Factor
- 5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
- 6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.



### Above 1 GHz [Antenna 0°]

Operation	Operation Mode: CH.0											
Frequency	Reading	Duty Cycle Factor	A.F.+C.LA.G.+D.F.	ANT. POL	Total	Limit	Margin	Measurement				
[MHz]	[dBuV/m]	[dB]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	Туре				
4804	53.54	0.00	-3.82	V	49.72	73.98	24.26	PK				
4804	43.57	2.01	-3.82	V	41.76	53.98	12.22	AV				
7206	54.81	0.00	-0.12	V	54.69	73.98	19.29	PK				
7206	43.88	2.01	-0.12	V	45.77	53.98	8.21	AV				
4804	54.58	0.00	-3.82	Н	50.76	73.98	23.22	PK				
4804	44.37	2.01	-3.82	Н	42.56	53.98	11.42	AV				
7206	55.31	0.00	-0.12	Н	55.19	73.98	18.79	PK				
7206	44.32	2.01	-0.12	Н	46.21	53.98	7.77	AV				

\*A.F. : Antenna Factor / C.L. : Cable Loss / A.G. : Amplifier Gain / D.F. : Distance Factor

- 1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
- 2. Measurements above show 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.
- 3. Radiated emissions measured in frequency above 1000 MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
- 4. Total = Reading Value + Antenna Factor + Cable Loss Amp Gain + Distance Factor
   + Duty Cycle Factor
- 5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
- 6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.



Frequency	Reading	Duty Cycle Factor	A.F.+C.LA.G.+D.F.	ANT. POL	Total	Limit	Margin	Measurement
[MHz]	[dBuV/m]	[dB]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	Туре
4880	51.27	0.00	-6.12	V	45.15	73.98	28.83	PK
4880	39.81	2.01	-6.12	V	35.7	53.98	18.28	AV
7320	52.69	0.00	-0.27	V	52.42	73.98	21.56	PK
7320	42.58	2.01	-0.27	V	44.32	53.98	9.66	AV
4880	51.99	0.00	-6.12	Н	45.87	73.98	28.11	PK
4880	40.30	2.01	-6.12	Н	36.19	53.98	17.79	AV
7320	53.47	0.00	-0.27	Н	53.2	73.98	20.78	PK
7320	43.52	2.01	-0.27	Н	45.26	53.98	8.72	AV

### Operation Mode: CH.19

- 1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
- 2. Measurements above show 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.
- 3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
- 4. Total = Reading Value + Antenna Factor + Cable Loss Amp Gain + Distance Factor
   + Duty Cycle Factor
- 5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
- 6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

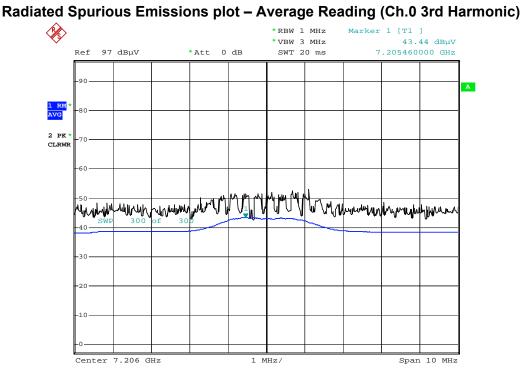


Frequency	Reading	Duty Cycle Factor	A.F.+C.LA.G.+D.F.	ANT. POL	Total	Limit	Margin	Measurement
[MHz]	[dBuV/m]	[dB]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	Туре
4960	50.84	0.00	-5.54	V	45.30	73.98	28.68	PK
4960	38.92	2.01	-5.54	V	35.39	53.98	18.59	AV
7440	51.67	0.00	0.79	V	52.46	73.98	21.52	PK
7440	39.55	2.01	0.79	V	42.35	53.98	11.63	AV
4960	51.17	0.00	-5.54	Н	45.63	73.98	28.35	PK
4960	39.20	2.01	-5.54	Н	35.67	53.98	18.31	AV
7440	52.35	0.00	0.79	Н	53.14	73.98	20.84	PK
7440	40.86	2.01	0.79	Н	43.66	53.98	10.32	AV

### Operation Mode: CH.39

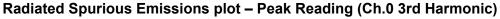
- 1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
- 2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
- Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
- 4. Total = Reading Value + Antenna Factor + Cable Loss Amp Gain + Distance Factor
   + Duty Cycle Factor
- 5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
- 6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

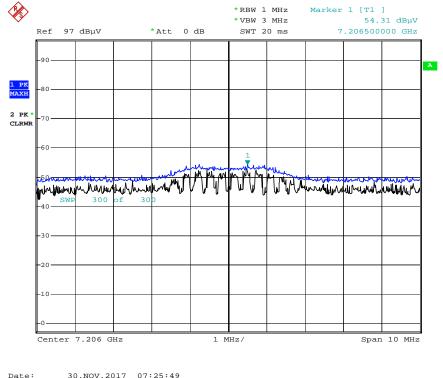




#### Date: 30.NOV.2017 07:24:50

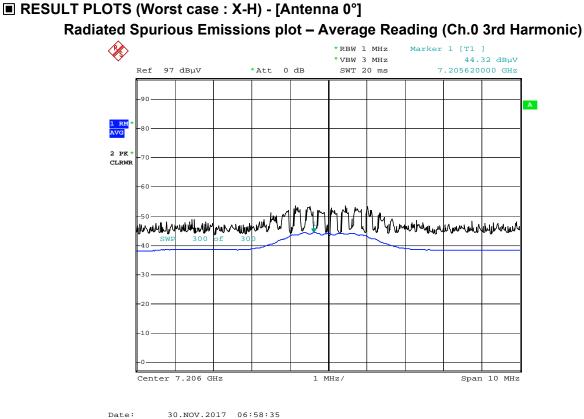
RESULT PLOTS (Worst case : X-H) - [Antenna 90°]



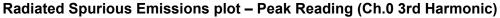


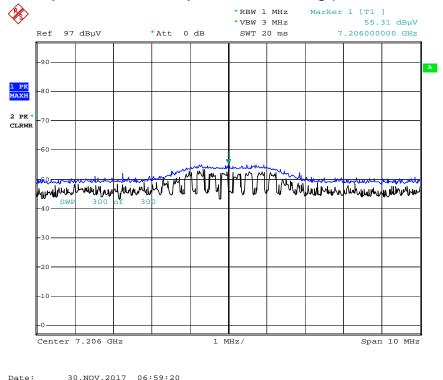
### Note : Only the worst case plots for Radiated Spurious Emissions.





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#### Note : Only the worst case plots for Radiated Spurious Emissions.



# 9.7.2 RADIATED RESTRICTED BAND EDGES

### Test Requirements and limit, §15.247(d) §15.205, §15.209, RSS-Gen(Issue 4) 8.10

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a) (See section 15.205(c)).

### [Antenna 90°]

Operation Mode	BT_LE
Operating Frequency	2402 MHz
Channel No.	0

Frequency	Reading	Duty Cycle Factor	A.F.+C.L.+D.F.	Ant. Pol.	Total	Limit	Margin	Measurement
[MHz]	[dBuV/m]	[dB]	[dB]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	Туре
2390.0	57.86	0.00	-3.91	Н	53.95	73.98	20.03	PK
2390.0	43.38	2.01	-3.91	Н	41.48	53.98	12.50	AV
2390.0	56.82	0.00	-3.91	V	52.91	73.98	21.07	PK
2390.0	42.59	2.01	-3.91	V	40.69	53.98	13.29	AV

- 1. Frequency range of measurement = 2310 MHz ~ 2390 MHz
- 2. Total = Reading Value + Antenna Factor + Cable Loss + Duty Cycle Factor + Distance Factor
- 3. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
- 4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.



Operation Mode	BT_LE
Operating Frequency	2480 MHz
Channel No.	39

Frequency	Reading	Duty Cycle Factor	A.F.+C.L.+D.F.	Ant. Pol.	Total	Limit	Margin	Measurement
[MHz]	[dBuV/m]	[dB]	[dB]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	Туре
2483.5	71.35	0.00	-3.62	Н	67.73	73.98	6.25	PK
2483.5	46.00	2.01	-3.62	Н	44.39	53.98	9.59	AV
2483.5	70.52	0.00	-3.62	V	66.90	73.98	7.08	PK
2483.5	45.29	2.01	-3.62	V	43.68	53.98	10.30	AV

### Notes:

1. Frequency range of measurement = 2483.5 MHz ~ 2500 MHz

2. Total = Reading Value + Antenna Factor + Cable Loss + Duty Cycle Factor + Distance Factor

3. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)

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



### [Antenna 0°]

Operation Mode	BT_LE
Operating Frequency	2402 MHz
Channel No.	0

Frequency	Reading	Duty Cycle Factor	A.F.+C.L.+D.F.	Ant. Pol.	Total	Limit	Margin	Measurement
[MHz]	[dBuV/m]	[dB]	[dB]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	Туре
2390.0	60.05	0.00	-3.91	н	56.14	73.98	17.84	PK
2390.0	43.37	2.01	-3.91	н	41.47	53.98	12.51	AV
2390.0	59.35	0.00	-3.91	V	55.44	73.98	18.54	PK
2390.0	42.84	2.01	-3.91	V	40.94	53.98	13.04	AV

### Notes:

1. Frequency range of measurement = 2310 MHz ~ 2390 MHz

2. Total = Reading Value + Antenna Factor + Cable Loss + Duty Cycle Factor + Distance Factor

3. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)

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



Operation Mode	BT_LE
Operating Frequency	2480 MHz
Channel No.	39

Frequency	Reading	Duty Cycle Factor	A.F.+C.L.+D.F.	Ant. Pol.	Total	Limit	Margin	Measurement
[MHz]	[dBuV/m]	[dB]	[dB]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	Туре
2483.5	70.69	0.00	-3.62	Н	67.07	73.98	6.91	PK
2483.5	45.92	2.01	-3.62	Н	44.31	53.98	9.67	AV
2483.5	70.16	0.00	-3.62	V	66.54	73.98	7.44	PK
2483.5	45.00	2.01	-3.62	V	43.39	53.98	10.59	AV

### Notes:

1. Frequency range of measurement = 2483.5 MHz ~ 2500 MHz

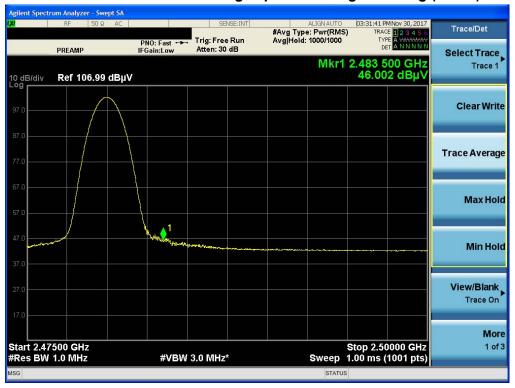
2. Total = Reading Value + Antenna Factor + Cable Loss + Duty Cycle Factor + Distance Factor

3. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)

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



### RESULT PLOTS (Worst case : X-H) - [Antenna 90°] Radiated Restricted Band Edges plot – Average Reading (Ch.39)



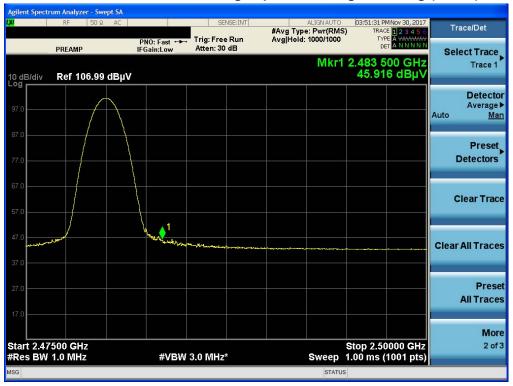
### Radiated Restricted Band Edges plot - Peak Reading (Ch.39)



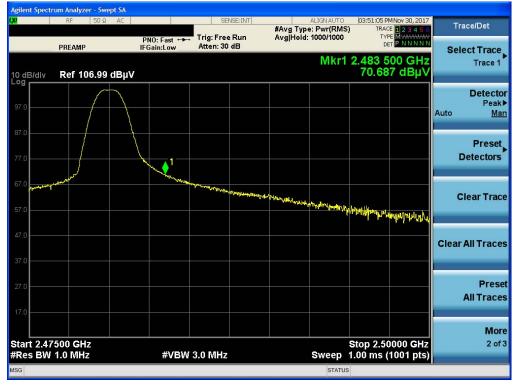
Note : Only the worst case plots for Radiated Restricted Band Edges.



### RESULT PLOTS (Worst case : X-H) - [Antenna 0°] Radiated Restricted Band Edges plot – Average Reading (Ch.39)



### Radiated Restricted Band Edges plot – Peak Reading (Ch.39)



Note : Only the worst case plots for Radiated Restricted Band Edges.



# 9.7.3 RECEIVER SPURIOUS EMISSIONS

ISED Rule(s)	RSS-Gen
Test Requirements:	Blow the table
Operating conditions:	Under normal test conditions
Method of testing:	Radiated
0/4 0 4/4	F < 1 GHz: RBW: 120 kHz, VBW: 300 kHz (Quasi Peak)
S/A. Settings:	F > 1 GHz: RBW: 1 MHz, VBW: 1 MHz (Peak)

Frequency	Field Strength
(MHz)	(microvolts/m at 3 meters)
30 – 88	100
88 - 216	150
216 – 960	200
Above 960	500

### **Operation Mode: Receive:**

30 MHz ~ 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBμN	dB /m	dB	(H/V)	dBµN/m	dBµN/m	dB
No critical peaks found							

#### Above 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBμN	dB /m	dB	(H/V)	dBµN/m	dBµN/m	dB
No critical peaks found							



# 9.8 POWERLINE CONDUCTED EMISSIONS

### Test Requirements and limit, §15.207, RSS-Gen(Issue 4) Section 8.8

For an intentional radiator which 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 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

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

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 Appendix 1 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**

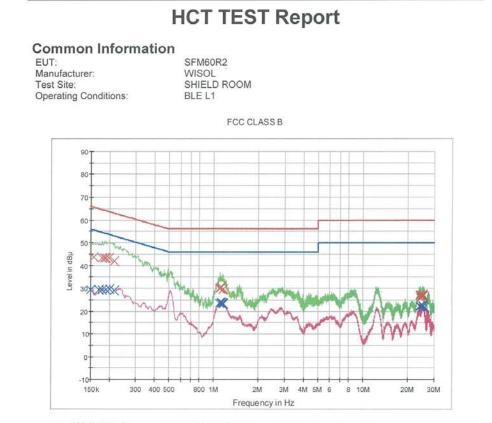
Quasi-peak(Final Result) = Reading Value + Correction Factor



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# RESULT PLOTSConducted Emissions (Line 1)

EMI Auto Test(17)



FCC CLASS B\_OP FCC CLASS B\_AV Preview Result 1-PK+
Preview Result 2-AVG X Final Result 1-QPK X Final Result 2-CAV

#### **Final Result 1**

Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.158000	43.5	9.000	Off	L1	9.6	22.1	65.6
0.178000	43.1	9.000	Off	L1	9.6	21.5	64.6
0.186000	43.2	9.000	Off	L1	9.6	21.0	64.2
0.190000	43.1	9.000	Off	L1	9.6	20.9	64.0
0.198000	43.1	9.000	Off	L1	9.6	20.6	63.7
0.216000	41.8	9.000	Off	L1	9.6	21.2	63.0
1.092000	30.1	9.000	Off	L1	9.7	25.9	56.0
1.104000	30.0	9.000	Off	L1	9.7	26.0	56.0
1.110000	30.3	9.000	Off	L1	9.7	25.7	56.0
1.120000	30.7	9.000	Off	L1	9.7	25.3	56.0
1.152000	29.5	9.000	Off	L1	9.7	26.5	56.0
1.162000	29.7	9.000	Off	L1	9.7	26.3	56.0
23.974000	27.1	9.000	Off	L1	10.3	32.9	60.0
24.318000	27.2	9.000	Off	L1	10.3	32.8	60.0
24.414000	26.0	9.000	Off	L1	10.3	34.0	60.0
25.110000	26.7	9.000	Off	L1	10.4	33.3	60.0
25.236000	27.4	9.000	Off	L1	10.4	32.6	60.0
25.298000	27.1	9.000	Off	L1	10.4	32.9	60.0

#### **Final Result 2**

2017-12-05

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#### EMI Auto Test(17)

Frequency (MHz)	CAverage (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	29.5	9.000	Off	L1	9.6	26.5	56.0
0.170000	29.5	9.000	Off	L1	9.6	25.5	55.0
0.178000	29.5	9.000	Off	L1	9.6	25.1	54.6
0.190000	29.4	9.000	Off	11	9.6	24.6	54.0
0.200000	29.7	9.000	Off	L1'	9.6	23.9	53.6
0.216000	29.1	9.000	Off	L1	9.6	23.9	53.0
1.098000	23.4	9.000	Off	L1	9.7	22.6	46.0
1.120000	23.6	9.000	Off	L1	9.7	22.4	46.0
1.124000	23.8	9.000	Off	L1	9.7	22.2	46.0
1.142000	23.4	9.000	Off	L1	9.7	22.6	46.0
1.150000	23.4	9.000	Off	L1	9.7	22.6	46.0
1.162000	23.2	9.000	Off	L1	9.7	22.8	46.0
23.974000	22.3	9.000	Off	L1	10.3	27.7	50.0
24.070000	22.1	9.000	Off	L1	10.3	27.9	50.0
24.318000	22.3	9.000	Off	L1	10.3	27.7	50.0
25.080000	22.2	9.000	Off	L1	10.4	27.8	50.0
25.236000	22.5	9.000	Off	L1	10.4	27.5	50.0
25.328000	21.6	9.000	Off	L1	10.4	28.4	50.0

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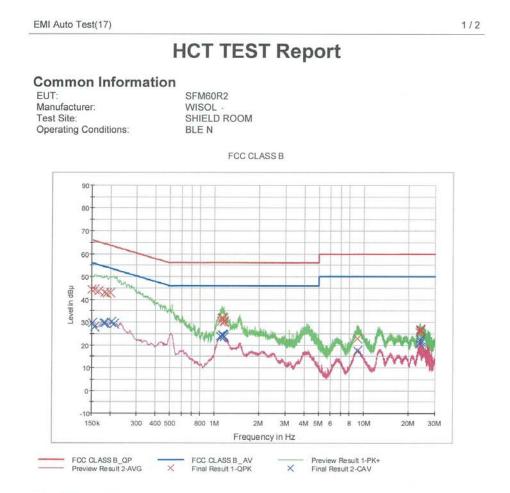
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2017-12-05

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### **Conducted Emissions (Line 2)**



#### **Final Result 1**

Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	44.3	9.000	Off	N	9.6	21.7	66.0
0.158000	44.1	9.000	Off	N	9.6	21.5	65.6
0.166000	43.6	9.000	Off	N	9.6	21.5	65.2
0.184000	42.8	9.000	Off	N	9.6	21.5	64.3
0.190000	42.5	9.000	Off	N	9.6	21.5	64.0
0.202000	42.8	9.000	Off	N	9.6	20.8	63.5
1.108000	30.4	9.000	Off	N	9.7	25.6	56.0
1.128000	31.6	9.000	Off	N	9.7	24.4	56.0
1.140000	31.9	9.000	Off	N	9.7	24.1	56.0
1.148000	31.5	9.000	Off	N	9.7	24.5	56.0
1.158000	30.3	9.000	Off	N	9.7	25.7	56.0
1.166000	30.1	9.000	Off	N	9.7	25.9	56.0
9.142000	22.9	9.000	Off	N	10.0	37.1	60.0
23.850000	25.6	9.000	Off	N	10.3	34.4	60.0
23.882000	26.8	9.000	Off	N	10.3	33.2	60.0
23.912000	26.3	9.000	Off	N	10.3	33.7	60.0
23.944000	26.7	9.000	Off	N	10.3	33.3	60.0
24.038000	26.2	9.000	Off	N	10.3	33.8	60.0

#### **Final Result 2**

2017-12-05

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#### EMI Auto Test(17)

Frequency (MHz)	CAverage (dBµV)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.152000	29.5	9.000	Off	N	9.6	26.4	55.9
0.158000	27.9	9.000	Off	N	9.6	27.6	55.6
0.180000	29.6	9.000	Off	N ·	9.6	24.8	54.5
0.186000	29.7	9.000	Off	N	9.6	24.5	54.2
0.204000	29.9	9.000	Off	N	9.6	23.6	53.4
0.212000	29.3	9.000	Off	N	9.6	23.8	53.1
1.098000	23.7	9.000	Off	N	9.7	22.3	46.0
1.108000	23.6	9.000	Off	N	9.7	22.4	46.0
1.130000	24.3	9.000	Off	N	9.7	21.7	46.0
1.138000	24.7	9.000	Off	N	9.7	21.3	46.0
1.148000	24.1	9.000	Off	N	9.7	21.9	46.0
1.158000	23.5	9.000	Off	N	9.7	22.5	46.0
9.142000	17.4	9.000	Off	N	10.0	32.6	50.0
23.820000	20.5	9.000	Off	N	10.3	29.5	50.0
23.882000	22.5	9.000	Off	N	10.3	27.5	50.0
23.914000	22.6	9.000	Off	N	10.3	27.4	50.0
23.974000	21.4	9.000	Off	N	10.3	28.6	50.0
24.038000	21.6	9.000	Off	N	10.3	28.4	50.0

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# **10. LIST OF TEST EQUIPMENT**

# 10.1 LIST OF TEST EQUIPMENT(Conducted Test)

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Rohde & Schwarz	ENV216 / LISN	12/23/2016	Annual	100073
Rohde & Schwarz	ESCI / Test Receiver	12/23/2016	Annual	100584
Agilent	N9020A / Signal Analyzer	06/13/2017	Annual	MY51110085
Agilent	N9030A / Signal Analyzer	11/22/2017	Annual	MY49431210
Agilent	N1911A / Power Meter	04/17/2017	Annual	MY45100523
Agilent	N1921A / Power Sensor	04/17/2017	Annual	MY52260025
Agilent	87300B / Directional Coupler	11/20/2017	Annual	3116A03621
Hewlett Packard	11667B / Power Splitter	06/12/2017	Annual	05001
Hewlett Packard	E3632A / DC Power Supply	06/30/2017	Annual	KR75303960
Agilent	8493C / Attenuator(10 dB)	07/10/2017	Annual	07560
Rohde & Schwarz	CBT / Bluetooth Tester	05/16/2017	Annual	100422
Rohde & Schwarz	EMC32 / Software	-	-	-



# 10.2 LIST OF TEST EQUIPMENT(Radiated Test)

Manufacturer	Model / Equipment	Calibration	Calibration	Serial No.
		Date	Interval	
Innco system	MA4000-EP / Antenna Position Tower	N/A	N/A	N/A
Innco system	CT0800 / Turn Table	N/A	N/A	N/A
Innco system	CO3000 / Controller(Antenna mast)	N/A	N/A	CO3000-4p
ETS	2090 / Controller(Turn table)	N/A	N/A	1646
Rohde & Schwarz	Loop Antenna	04/19/2017	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	04/06/2017	Biennial	760
Schwarzbeck	BBHA 9120D / Horn Antenna	08/01/2017	Biennial	9120D-1151
Schwarzbeck	BBHA9170 / Horn Antenna(15 GHz ~ 40 GHz)	04/25/2017	Biennial	BBHA9170124
Rohde & Schwarz	FSP / Spectrum Analyzer	09/21/2017	Annual	836650/016
Rohde & Schwarz	FSV40-N / Spectrum Analyzer	09/27/2017	Annual	101068-SZ
Wainwright Instruments	WHKX10-2700-3000-18000-40SS / High Pass Filter	08/01/2017	Annual	4
Wainwright Instruments	WHKX8-6090-7000-18000-40SS / High Pass Filter	07/11/2017	Annual	5
Wainwright Instruments	WRCJV2400/2483.5-2370/2520-60/12SS / Band Reject Filter	06/30/2017	Annual	2
Wainwright Instruments	WRCJV5100/5850-40/50-8EEK / Band Reject Filter	01/24/2017	Annual	2
H.P.	8491A / Attenuator(10 dB)	08/01/2017	Annual	18593
CERNEX	CBLU1183540 / Power Amplifier	01/25/2017	Annual	24614
CERNEX	CBL06185030 / Power Amplifier	01/25/2017	Annual	24615
CERNEX	CBL18265035 / Power Amplifier	01/23/2017	Annual	22966
CERNEX	CBL26405040 / Power Amplifier	06/30/2017	Annual	25956
TESCOM	TC-3000C / Bluetooth Tester	03/31/2017	Annual	3000C000276