# **TEST REPORT**

# **Dt&C**

## DT&C Co., Ltd.

42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17042 Tel : 031-321-2664, Fax : 031-321-1664

1. Report No : DRTFCC1703-0041(3)

2. Customer

• Name : SOLUM CO.,LTD.

• Address : 4,5,6th F, 357, Guseong-ro, Giheung-gu, Yongin-si, Gyeonggi-do, South Korea

3. Use of Report : FCC & IC Original Grant

4. Product Name / Model Name : ESL Gateway / SLG-CR101 FCC ID: 2AFWN-SLG-CR101 / IC: 22800-SLGCR101

5. Test Method Used : KDB 558074, ANSI C63.10-2013

Test Specification : FCC Part 15 Subpart C.247

RSS-247 Issue 1 (2015-05), RSS-GEN Issue 4 (2014-11)

6. Date of Test : 2017.08.23 ~ 2017.08.25

- 7. Testing Environment : See appended test report.
- 8. Test Result : Refer to the attached test result.

Affirmation	Tested by		Technical Manager	No
	Name : SunGeun Lee	(Stopalyre)	Name : GeunKi Son	(Signature)

The test results presented in this test report are jimited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose. This test report shall not be reproduced except in full, without the written approval of DT&C Co., Ltd.

2017.09.11.

## DT&C Co., Ltd.

If this report is required to confirmation of authenticity, please contact to report@dtnc.net

## **Test Report Version**

Test Report No.	Date	Description
DRTFCC1703-0041	Mar. 17, 2017	Initial issue
DRTFCC1703-0041(1)	Aug. 09, 2017	Retest and added IC
DRTFCC1703-0041(2)	Sep. 05, 2017	All items retested.
DRTFCC1703-0041(3)	Sep. 11, 2017	Add PSD data.

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## **1. General Information**

#### 1.1 Testing Laboratory

#### DT&C Co., Ltd.

The 3 m test site and conducted measurement facility used to collect the radiated data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 17042. The site is constructed in conformance with the requirements.

#### - FCC MRA Accredited Test Firm No. : KR0034

- IC Test site	- IC Test site No. : 5740A-3				
www.dtnc.net	www.dtnc.net				
Telephone	:	+ 82-31-321-2664			
FAX : +82-31-321-1664					

### **1.2 Details of Applicant**

Applicant	:	SOLUM CO.,LTD.
Address	:	4,5,6th F, 357, Guseong-ro, Giheung-gu, Yongin-si, Gyeonggi-do, South Korea
Contact person	:	Ki Dong Lee

#### 1.3 Description of EUT

EUT	ESL Gateway
Model Name	SLG-CR101
Add Model Name	NA
Hardware version	2.4-Sub-GHz_RT-Gateway_R01
Software version	HITS 4.0.1
Power Supply	Adapter: DC 5.0 V, POE: DC 48 V
Frequency Range	2405 ~ 2480MHz (16 channels)
Max. RF Output Power	4.03 dBm
Modulation Technique	O-QPSK
Antenna Specification	Antenna Type: Internal Antenna <sup>NOTE 1</sup> Gain: 3.9 dBi(PK)

Note 1: This device has two transceivers and uses the same antenna.



## **1.4 Declaration by the applicant / manufacturer**

- N/A

## **1.5 Test Conditions**

Ambient Condition			
<ul> <li>Temperature</li> </ul>	+23 ℃ ~ +27 ℃		
<ul> <li>Relative Humidity</li> </ul>	42 % ~ 45 %		

## **1.6 Measurement Uncertainty**

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C 63.4-2014. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95 % level of confidence. The measurement uncertainty shown below meet or exceeds the U<sub>CISRP</sub> measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Test items	Measurement uncertainty
Transmitter Output Power	0.7 dB (The confidence level is about 95 %, k = 2)
Conducted spurious emission	1.0 dB (The confidence level is about 95 %, k = 2)
AC conducted emission	2.4 dB (The confidence level is about 95 %, k = 2)
Radiated spurious emission (1 GHz Below)	5.1 dB (The confidence level is about 95 %, k = 2)
Radiated spurious emission (1 GHz ~ 18 GHz)	5.4 dB (The confidence level is about 95 %, k = 2)
Radiated spurious emission (18 GHz Above)	5.3 dB (The confidence level is about 95 %, k = 2)

## **1.7 Support Equipment**

Equipment Manufacturer		Model No.	Serial No.	Note
POE	HP	PD-3501G/AC	CN35FFX099	-
-	-	-	-	-

## 1.8 Test Equipment List

Туре	Manufacturer	Model	Cal. Date (yy/mm/dd)	Next Cal. Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent Technologies	N9020A	17/07/12	18/07/12	MY46471601
Spectrum Analyzer	Agilent Technologies	N9020A	16/10/11	17/10/11	MY46471251
DC Power Supply	Agilent	66332A	17/01/11	18/01/11	US37473831
Thermohygrometer	нст	HCT-1	16/09/09	17/09/09	NONE
Signal Generator	Rohde Schwarz	SMBV100A	17/01/04	18/01/04	255571
Signal Generator	Rohde Schwarz	SMF100A	17/04/21	18/04/21	102341
Multimeter	FLUKE	17B	17/04/12	18/04/12	26030065WS
Loop Antenna	Schwarzbeck	FMZB1513	16/04/22	18/04/22	1513-128
BILOG ANTENNA	Schwarzbeck	VULB 9160	16/05/13	18/05/13	3358
Horn Antenna	ETS-LINDGREN	3117	16/05/03	18/05/03	00140394
Horn Antenna	A.H.Systems Inc.	SAS-574	15/09/03	17/09/03	155
High-pass filter	Wainwright	WHKX12-2580- 3000-18000-80SS	16/09/09	17/09/09	3
High-pass filter	Wainwright	WHNX6-6320- 8000-26500-40CC	16/09/13	17/09/13	1
PreAmplifier	Agilent	8449B	17/01/11	18/01/11	3008A00370
PreAmplifier	TSJ	MLA-010K01-B01- 27	17/03/06	18/03/06	1844539
EMI Test Receiver	Rohde Schwarz	ESR7	17/02/16	18/02/16	101061
EMI TEST RECEIVER	R&S	ESCI	17/02/26	18/02/16	100364
PULSE LIMITER	Rohde Schwarz	ESH3-Z2	17/01/03	18/01/03	101334
SINGLE-PHASE MASTER	NF	4420	16/09/08	17/09/08	3049354420023
Artificial Mains Network	Narda S.T.S. / PMM	PMM L2-16B	17/06/07	18/06/07	000WX20305

Note: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2006.

## 1.9 Summary of Test Results

FCC Part	RSS Std.	Parameter	Limit	Test Condition	Status Note 1				
15.247(a)	RSS-247 [5.2]	6 dB Bandwidth	> 500 kHz		С				
15.247(b)	RSS-247 [5.4]	Transmitter Output Power	< 1 Watt		С				
15.247(d)	RSS-247 [5.5]	Out of Band Emissions / Band Edge	20 dBc in any 100 kHz BW	Conducted	С				
15.247(e)	RSS-247 [5.2]	Transmitter Power Spectral Density	< 8 dBm/3 kHz		С				
-	RSS-Gen [6.6]	Occupied Bandwidth (99 %)	RSS-Gen(6.6)		С				
15.247(d) 15.205 15.209	RSS-247 [5.5] RSS-Gen [8.9] RSS-Gen [8.10]	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	FCC 15.209 limits	Radiated	с				
15.207	RSS-Gen [8.8]	AC Line Conducted Emissions	FCC 15.207 limits	AC Line Conducted	С				
15.203	RSS-Gen [8.3]	Antenna Requirements	FCC 15.203	-	С				
Note 1: C=C	Note 1: C=Comply NC=Not Comply NT=Not Tested NA=Not Applicable								

## 2. Test Methodology

Generally the tests were performed according to the KDB558074 D01 v04. And ANSI C63.10-2013 was used to reference appropriate EUT setup and maximizing procedures of radiated spurious emission and AC line conducted emission testing.

## 2.1 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.

#### 2.2 EUT Exercise

The EUT was operated in the test 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.

#### 2.3 General Test Procedures

#### **Conducted Emissions**

The power-line conducted emission test procedure is not described on the KDB 558074.

So this test was fulfilled with the requirements in Section 6.2 of ANSI C63.10.

The EUT is placed on the wooden table, which is 0.8 m above ground plane and the conducted emissions from the EUT measured in the frequency range between 0.15MHz and 30MHz using CISPR Quasi-peak and Average detector.

#### **Radiated Emissions**

Basically the radiated tests were performed with KDB 558074. But some requirements and procedures like test site requirements, EUT setup and maximizing procedure were fulfilled with the requirements in Section 5 and 6 of the ANSI C63.10 as stated on section 12.1 of the KDB 558074.

The EUT is placed on a non-conductive table, which is above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 1 or 3 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 highest emission, the relative positions of the EUT were rotated through three orthogonal axes.

#### 2.4 Description of Test Modes

The EUT has been tested with the operating condition for maximizing the emission characteristics. A test program is used to control the EUT for staying in continuous transmitting. The lowest, middle and highest channels were tested and reported.

Test Mode		Test Frequency [MHz]			
	[TM]		Lowest channel	Middle channel	Highest channel
TM 1	Transceiver 1 (ZIGBEE - Modem#2)	DC Adapter	2405	2440	2480
TM 2	Transceiver 2 (ZIGBEE - Modem#4)	DC Adapter	2405	2440	2480
ТМ 3	Transceiver 1 (ZIGBEE - Modem#2)	POE	2405	2440	2480
TM 4	Transceiver 2 (ZIGBEE - Modem#4)	POE	2405	2440	2480

## 2.5 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, which is traceable to recognized national standards.

## 3. Test Result

## 3.1 Maximum Peak Conducted Output Power

## Test Requirements and limit, §15.247(b) & RSS-247 [5.4]

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.

#### 3.1.1 Test Setup

Refer to the APPENDIX I.

#### 3.1.2 Test Procedures

Maximum Peak Conducted Output Power is measured using Measurement Procedure of KDB558074

1. Set the RBW ≥ DTS bandwidth. Actual RBW = 2 MHz

- 2. Set  $VBW \ge 3 \times RBW$ . Actual VBW = 6 MHz
- 3. Set span ≥ 3 x RBW.
- 4. Sweep time = auto couple
- 5. Detector = peak
- 6. Trace mode = max hold
- 7. Allow trace to fully stabilize
- 8. Use peak marker function to determine the peak amplitude level.

#### 3.1.3 Test Results

Test Mode	Tested Channel	Frame Average Output Power	Peak Output Power
Test Mode	resteu Channer	dBm	dBm
	Lowest	3.85	4.03
TM 1	Middle	3.77	3.92
	Highest	3.21	3.52
	Lowest	2.86	3.85
TM 2	Middle	3.57	3.71
	Highest	-4.86	-4.65



TM 1 & Test Channel : Lowest



#### **Peak Output Power**

TM 1 & Test Channel : Middle



#### TM 1 & Test Channel : Highest



#### TM 2 & Test Channel : Lowest



#### **Peak Output Power**

TM 2 & Test Channel : Middle



#### TM 2 & Test Channel : Highest





## 3.2 6 dB Bandwidth Measurement

## Test Requirements and limit, §15.247(a) & RSS-247 [5.2]

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

#### The minimum permissible 6 dB bandwidth is 500 kHz.

#### 3.2.1 Test Setup

Refer to the APPENDIX I.

#### 3.2.2 Test Procedures

The transmitter output is connected to the Spectrum Analyzer and used following test procedure of KDB558074.

- 1. Set resolution bandwidth (RBW) = 100 kHz.
- 2. Set the video bandwidth (VBW)  $\ge$  3 x RBW.

#### (RBW : 100 kHz / VBW : 300 kHz)

- 3. Detector = Peak.
- 4. Trace mode = **max hold**.
- 5. Sweep = auto couple.
- 6. Allow the trace to stabilize.
- 7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

#### 3.2.3 Test Results

Test Mode	Tested Channel	Test Results [MHz]
	Lowest	1.508
TM 1	Middle	1.519
	Highest	1.508
	Lowest	1.511
TM 2	Middle	1.609
	Highest	1.476

#### TM 1 & Test Channel : Lowest



#### 6 dB Bandwidth

#### TM 1 & Test Channel : Middle



#### TM 1 & Test Channel : Highest



#### TM 2 & Test Channel : Lowest



#### 6 dB Bandwidth

#### TM 2 & Test Channel : Middle



#### TM 2 & Test Channel : Highest



#### 3.3 Maximum Power Spectral Density.

#### Test requirements and limit, §15.247(e) & RSS-247 [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 power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission

#### 3.3.1 Test Setup

Refer to the APPENDIX I.

#### 3.3.2 Test Procedures

#### Method PKPSD of KDB558074 is used.

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

#### 3.3.3 Test Results

Test Mode	Tested Channel	PKPSD [dBm] RBW (100 kHz)	PKPSD [dBm] <sup>Note 1</sup> RBW(3 kHz)
	Lowest	-1.24	-16.46
TM 1	Middle	-1.33	-16.55
	Highest	-1.71	-16.93
	Lowest	-1.32	-16.54
ТМ 2	Middle	-1.62	-16.84
	Highest	-9.65	-24.87

Note 1: Calculated result for 3 kHz bandwidth

= Measured result for 100 kHz bandwidth + [10 x Log (3 kHz/100 kHz) = -15.22 dB]

#### TM 1& Test Channel : Lowest



#### Maximum PKPSD

#### TM 1& Test Channel : Middle





TM 1 & Test Channel : Highest



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#### TM 2 & Test Channel : Lowest



## Maximum PKPSD

#### TM 2 & Test Channel : Middle





TM 2 & Test Channel : Highest





## 3.4 Unwanted Emissions (Conducted)

## Test requirements and limit, §15.247(d) & RSS-247 [5.5]

**§15.247(d)** specifies that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:

If **the peak output power procedure** is used to measure the fundamental emission power to demonstrate compliance to **15.247(b)(3)** requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated **by at least 20 dB** relative to the maximum measured in-band peak PSD level.

If the average output power procedure is used to measure the fundamental emission power to demonstrate

compliance to **15.247(b)(3)** requirements, then the power in any 100 kHz outside of the authorized frequency band

shall be attenuated by at least 30 dB relative to the maximum measured in-band average PSD level.

In either case, attenuation to levels below the general emission limits specified in §15.209(a) is not required.

## 3.4.1 Test Setup

Refer to the APPENDIX I.

#### 3.4.2 Test Procedures

The transmitter output is connected to a spectrum analyzer.

- Measurement Procedure 1 Reference Level
- 1. Set instrument center frequency to DTS channel center frequency.
- 2. Set the span to  $\geq$  1.5 times the DTS bandwidth.
- 3. Set the RBW = 100 kHz.
- 4. Set the VBW  $\geq$  3 x RBW.
- 5. Detector = peak.
- 6. Sweep time = auto couple.
- 7. Trace mode = max hold.
- 8. Allow trace to fully stabilize.
- 9. Use the peak marker function to determine the maximum PSD level LIMIT LINE = 20 dB below of the reference level.

#### - Measurement Procedure 2 - Unwanted Emissions

- 1. Set the center frequency and span to encompass frequency range to be measured.
- 2. Set the RBW = 100 kHz.(Actual 1 MHz , See below note)
- 3. Set the VBW ≥ 3 x RBW.(Actual 3 MHz, See below note)
- 4. Detector = **peak**.
- 5. Ensure that the number of measurement points  $\geq$  span / RBW
- 6. Sweep time = **auto couple.**
- 7. Trace mode = **max hold.**
- 8. Allow the trace to stabilize (this may take some time, depending on the extent of the span).
- 9. Use the peak marker function to determine the maximum amplitude level.

Note : The conducted spurious emission was tested with below settings.

Frequency range	RBW	VBW	Detector	Trace	Sweep Point
9 kHz ~ 30 MHz	100 kHz	300 kHz			
30 MHz ~ 10 GHz	1 MHz	3 MHz	Peak	Max Hold	40001
10 GHz ~ 25 GHz	1 MHz	3 MHz			

If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SPAN = 100 MHz and BINS = 2001 to get accurate emission level within 100 kHz BW.



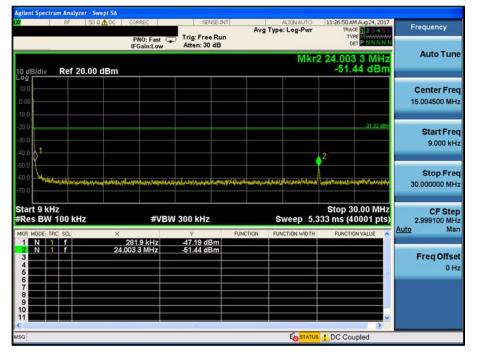
## 3.4.3 Test Results

m Ar Frequency Avg Type: Log-Pwr PNO: Wide Trig: Free Run IFGain:Low Atten: 30 dB TYPE MININ Auto Tune Mkr1 2.404 876 GHz -1.32 dBm Ref 20.00 dBm 10 dB/div Center Freq 2.40500000 GHz Start Freq 2.403500000 GHz Stop Freq 2.406500000 GHz CF Step 300.000 kHz Man Auto Freq Offset 0 Hz Center 2.405000 GHz #Res BW 100 kHz Span 3.000 MHz Sweep 1.000 ms (3001 pts) #VBW 300 kHz

Reference (TM 1 & Test Channel : Lowest)

Low Band-edge





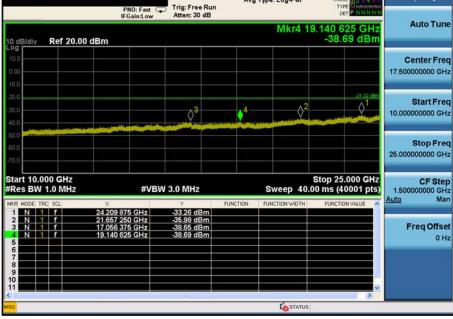
## Conducted Spurious Emissions 1 (TM 1 & Test Channel : Lowest)

## Conducted Spurious Emissions 2 (TM 1 & Test Channel : Lowest)

RF 50	PNO:	Fast 😱 Trig: Fre		ALIGNAUTO Avg Type: Log-Pwr	11:29:12 AM Aug 24, 2017 TRACE 2 3 4 5 TYPE M MANNAN DET P NN N N N	Frequency
dB/div Ref 20.00	) dBm			Mkr	10 4.429 76 GHz -46.44 dBm	Auto Tune
00 000	1 					Center Free 5.015000000 GH:
0.0	\ <sup>8</sup> \ <sup>6</sup> \	3	<b>♦</b> <sup>5</sup>	$\diamond^2$ $\diamond^4$	-21.32 dBs	Start Free 30.000000 MH:
0.0 0.0 0.0		Party inter second second				Stop Free 10.000000000 GH:
tart 30 MHz Res BW 1.0 MHz	×	#VBW 3.0 MH;	FUNCT		Stop 10.000 GHz 8.67 ms (40001 pts)	CF Step 997.000000 MH Auto Mar
1 N 1 f 2 N 1 f 3 N 1 f 4 N 1 f 5 N 1 f 6 N 1 f 7 N 1 f	2,405 60 G 6,386 87 G 3,188 99 G 7,705 90 G 5,395 36 G 2,698 47 G 8,905 29 G	Hz         3.87 c           GHz         -43.65 d           GHz         -44.15 d           GHz         -44.27 d           GHz         -44.52 d           GHz         -44.53 d           GHz         -45.33 d	Bm Bm Bm Bm Bm Bm Bm			Freq Offse 0 H
8 N 1 f 9 N 1 f 0 N 1 f	2.107 50 G 4.273 98 G 4.429 76 G	GHz -46.43 d	Bm			

#### Avg Type: Log-Pwr Frequency PNO: Fast Trig: Free Run IFGain:Low Atten: 30 dB DET Auto Tune Mkr4 19.140 625 GHz -38.69 dBm Ref 20.00 dBm 10 dB/div Center Freq 17.50000000 GHz -21 31 \_\_\_\_\_\_1 Start Freq $\Diamond^3$ $\Diamond^2$ ●4 10.00000000 GHz Stop Freq 25.00000000 GHz

## Conducted Spurious Emissions 3 (TM 1 & Test Channel : Lowest)

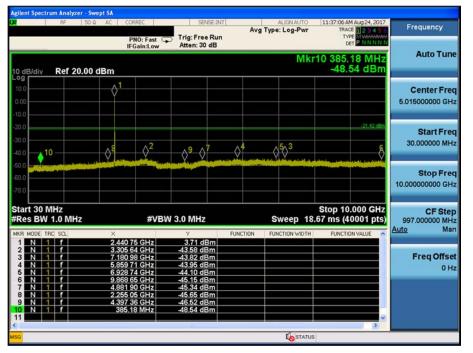




#### Reference (TM 1 & Test Channel : Middle)

## Conducted Spurious Emissions 1 (TM 1 & Test Channel : Middle)

RF 50 🔉 🔬 DC	CORREC	SENSE:INT		ALIGNAUTO	11:35:05 AM Aug 24, 2	017 Frequency
	PNO: Fast G	Trig: Free Run Atten: 30 dB	Avg	Type: Log-Pwr	TRACE 2 2 4 TYPE MUMAN DET P NNN	
dB/div Ref 20.00 dBm				Mkr	2 24.022 0 MH -51.07 dB	
9 00 00						Center Fro 15.004500 Mi
10 10 10 10					-21.42	Start Fr 9.000 k
	مرور والمعالمة المرود ف	والمستحد والمعتقان والمعالية المحافظ ألم	ن. مەلەرلىيە ھەرەر مەسىرى	and the second	and the stress and the bar	Stop Fr 30.000000 M
						30.000000 M
art 9 kHz		/ 300 kHz			Stop 30.00 M 33 ms (40001 p	Hz CF Sto ts) 2.999100 M
art 9 kHz Res BW 100 kHz	#VBW	/ 300 kHz	FUNCTION		Stop 30.00 M	Hz CF Str ts) 2.999100 M
art 9 KHz Res BW 100 KHz R MODE TRC SCL X N 1 f 2 N 1 f 2 N 1 f 2 N 2 CL X 2 N 2 CL X 2 N 2 CL X 2 N 2 CL X 2 CL X		/ 300 kHz		Sweep 5.3	Stop 30.00 M 33 ms (40001 p	Hz CF Sto 2.999100 M Auto M
art 9 kHz tes BW 100 kHz R MODE TRC SCL X N 1 f 24	#VBW	/ 300 kHz -48.23 dBm		Sweep 5.3	Stop 30.00 M 33 ms (40001 p	Hz ts) Auto Freq Offs



## Conducted Spurious Emissions 2 (TM 1 & Test Channel : Middle)

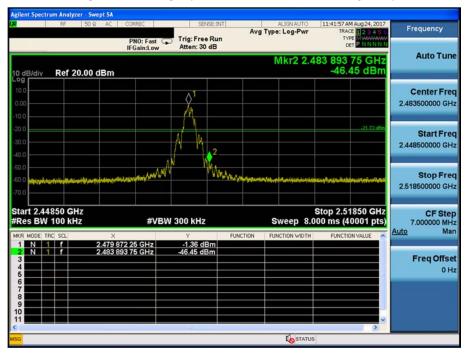
## Conducted Spurious Emissions 3 (TM 1 & Test Channel : Middle)

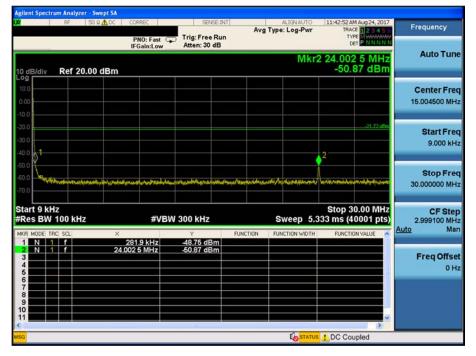
	RF	50 Q AC	CORREC	SENSE:	Avg	ALIGNAUTO	11:38:36 AM Aug 24, 2 TRACE	Frequency
_	_		PNO: Fast IFGain:Low	Trig: Free Ru Atten: 30 dB			DET P NNN	NN
dB/div	Ref 20.0	00 dBm				Mkr7 1	2.244 000 GI -43.22 dB	
								Center Fre
		7	6	5	<b>≬</b> <sup>4</sup> <b>≬</b> <sup>3</sup>	<b></b>	-21.42)	Start Fre
0.0 0.0 0.0								Stop Fr 25.00000000 G
art 10.0 Res BW	00 GHz 1.0 MHz		#VI	3W 3.0 MHz		Sweep 40	Stop 25.000 G .00 ms (40001 p	ts) 1.50000000 G
R MODE TR	C SCL	× 24.1	08 250 GHz	Y -33.70 dBm	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	Auto M
2 N 1 8 N 1 4 N 1	f f f	21.7 19.1 18.5 16.9	02 625 GHz 28 250 GHz 72 125 GHz 94 125 GHz	-35.37 dBm -39.12 dBm -39.15 dBm -39.31 dBm				Freq Offs 01
5 N 1 N 1	f f		54 625 GHz 44 000 GHz	-42.48 dBm -43.22 dBm				
								×
						STATUS	6	



#### Reference (TM 1 & Test Channel : Highest)

High Band-edge (TM 1 & Test Channel : Highest)





## Conducted Spurious Emissions 1 (TM 1 & Test Channel : Highest)

## Conducted Spurious Emissions 2 (TM 1 & Test Channel : Highest)

RF	50 Q AC	CORREC	SENSE:INT	A		LIGN AUTO		AM Aug 24, 20 ACE		Frequency
		PNO: Fast G	Trig: Free Run Atten: 30 dB	Avg	Type:	Log-Pwr			-	
dB/div Rei	20.00 dBm					Mkr1		9 63 GH		Auto Tun
		,1								Center Fre 5.015000000 GH
3.0 3.0 3.0	0 <sup>9</sup>		5		2 <sup>2</sup>	{4}		103	7	Start Fre 30.000000 M⊦
0.0 0.0 0.0										Stop Fre 10.000000000 GF
tart 30 MHz Res BW 1.0 M	ИНz	#VBV	V 3.0 MHz		Sw	veep 18		0.000 GH 40001 pt	s)	CF Ste 997.000000 MH
KR MODE TRC SCL	×	179 63 GHz	۲ 3.39 dBm	FUNCTION	FUNC	TION WIDTH	FUNC	TION VALUE	^ ^	
2 N 1 F 3 N 1 F 4 N 1 F	6.8 3.2 7.8 4.9	330 79 GHz 213 92 GHz 530 38 GHz 932 25 GHz	-43.61 dBm -43.80 dBm -44.50 dBm -44.84 dBm							Freq Offs 0 F
6 N 1 f 7 N 1 f 8 N 1 f 9 N 1 f	9.1 8.9 1.9	196 68 GHz 704 89 GHz 949 91 GHz 925 55 GHz 709 63 GHz	44.92 dBm 45.45 dBm 45.59 dBm 45.60 dBm 45.67 dBm							
	8.	09 63 GHZ	-45,67 dBm					>		
-						STATUS			-	

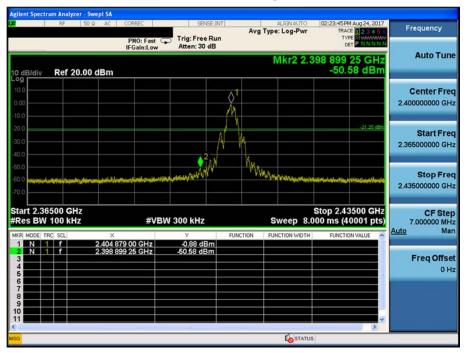
#### Frequency Avg Type: Log-Pwr PNO: Fast Trig: Free Run IFGain:Low Atten: 30 dB DET Auto Tune Mkr7 18.662 125 GHz -39.33 dBm Ref 20.00 dBm 10 dB/div Center Freq 17.50000000 GHz \$4 Start Freq $\langle 3 \rangle$ \$6 <sup>7</sup> **◊**<sup>5</sup> 10.00000000 GHz Stop Freq 25.00000000 GHz Start 10.000 GHz #Res BW 1.0 MHz Stop 25.000 GHz Sweep 40.00 ms (40001 pts) CF Step 1.500000000 GHz .uto Man #VBW 3.0 MHz Auto N 1 f N 1 f N 1 f N 1 f N 1 f N 1 f N 1 f N 1 f 33.69 dBm 33.71 dBm 34.68 dBm 36.11 dBm 38.68 dBm 39.08 dBm 39.08 dBm Freq Offset 22 297 375 GHz 19.421 500 GHz 17.057 875 GHz 18.662 125 GHz 375 GHz 500 GHz 0 Hz STATUS

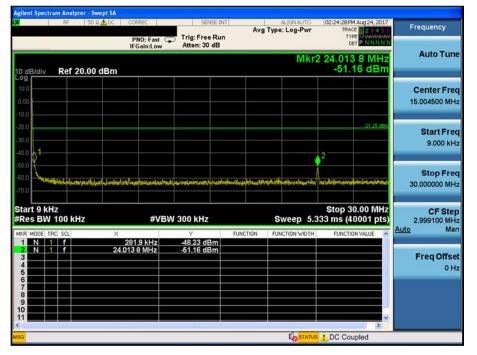
## Conducted Spurious Emissions 3 (TM 1 & Test Channel : Highest)



#### Reference (TM 2 & Test Channel : Lowest)

Low Band-edge





## Conducted Spurious Emissions 1 (TM 2 & Test Channel : Lowest)

## Conducted Spurious Emissions 2 (TM 2 & Test Channel : Lowest)

Frequency		02:26:10 PM A TRACE TYPE DET	ALIGNAUTO ype: Log-Pwr	Avg 1	Run	Trig: Free F Atten: 30 d	PNO: Fast G	BR AC	RF 5	
Auto Tur		) 1.995 8 -45.97	Mkr10					0 dBm	Ref 20.0	dB/div
Center Fre 5.015000000 GH								^1		
Start Fre 30.000000 MH	21.25 dBm	<b>0</b> *	¢ <sup>4</sup>		\$	\$6		10		
Stop Fre 10.00000000 GF										
CF Ste 997.000000 MH Auto Ma	01 pts)	Stop 10.0 67 ms (400	Sweep 18.	CTION	FUNC	3.0 MHz	#VBV	×	.0 MHz	es BW
Freq Offs 0 H					n n n	3.77 dBr -43.83 dBr -43.93 dBr -44.14 dBr -44.27 dBr	5 60 GHz 1 05 GHz 1 30 GHz 9 82 GHz 1 02 GHz	3.17 6.41 7.06 5.59	f f f f f	N 1 N 1 N 1 N 1
					n n n	-44.63 dBn -45.42 dBn -45.76 dBn -45.80 dBn -45.97 dBn	9 62 GHz 2 00 GHz 7 47 GHz 4 50 GHz 5 83 GHz	9.50 8.84 9.83	f f f f f	N 1 N 1 N 1 N 1 N 1
	>		STATUS							

#### Frequency Avg Type: Log-Pwr PNO: Fast Trig: Free Run IFGain:Low Atten: 30 dB DET Auto Tune Mkr6 14.059 000 GHz -41.42 dBm Ref 20.00 dBm 10 dB/div Center Freq 17.50000000 GHz 21.2 Start Freq $\Diamond^2$ $\Diamond^4 \Diamond^5$ $\partial^3$ **6** 10.00000000 GHz Stop Freq 25.00000000 GHz Start 10.000 GHz #Res BW 1.0 MHz Stop 25.000 GHz Sweep 40.00 ms (40001 pts) CF Step 1.500000000 GHz .uto Man #VBW 3.0 MHz Auto -33.78 dBm -33.98 dBm -36.04 dBm -39.02 dBm -39.18 dBm -41.42 dBm 24.292 000 GHz 21.694 750 GHz 17.063 125 GHz 17.735 875 GHz 14.059 000 GHz N 1 F N 1 F N 1 F N 1 F N 1 F N 1 F Freq Offset 0 Hz STATUS

## Conducted Spurious Emissions 3 (TM 2 & Test Channel : Lowest)



#### Reference (TM 2 & Test Channel : Middle)

#### Conducted Spurious Emissions 1 (TM 2 & Test Channel : Middle)

RF 50 R 🛕 DC	CORREC	SENSE:IN		ALIGN AUTO	02:30:12 PM AU		Frequency
	PNO: Fast G	Trig: Free Run Atten: 30 dB		Type: Log-Pwr		23456 ////////////////////////////////////	
dB/div Ref 20.00 dBm				Mkr	2 24.005 5 -50.62		Auto Tur
9							Center Fre 15.004500 MF
10 10 10 10					2	21.52 cBm	Start Fre 9.000 ki
3.0 <b>K</b>					/		
0.0	haterengenheitersternet	nikharena arana	North State State Street		han shikara dhu dalay	ynyithinini	ALCOND. 2010.0
art 9 kHz		V 300 kHz	فىردوتارور <sub>ا</sub> يورانور ارومانغ		Stop 30.0 33 ms (400	00 MHz 01 pts)	30.000000 M CF Sto 2.999100 M
art 9 kHz Res BW 100 kHz	#VBV	¥ 300 kHz	FUNCTION		Stop 30.0	00 MHz 01 pts)	30.000000 M CF Ste 2.999100 M
art 9 kHz ess BW 100 kHz R MODE TRC SCL X N 1 7 20	#VBV	V 300 kHz		Sweep 5.3	Stop 30.0 333 ms (400	00 MHz 01 pts)	Stop Fro 30.000000 MI CF Sto 2.999100 MI Auto Freq Offs 01
0	#VBV 295.4 kHz	V 300 kHz -49.48 dBm		Sweep 5.3	Stop 30.0 333 ms (400	00 MHz 01 pts)	30.000000 M CF Str 2.999100 M Auto Freq Offs

#### Frequency Avg Type: Log-Pwr PNO: Fast Trig: Free Run IFGain:Low Atten: 30 dB Auto Tune Mkr10 4.251 55 GHz -45.94 dBm Ref 20.00 dBm $\Diamond$ **Center Freq** 5.015000000 GHz Start Freq 30.000000 MHz $\Diamond^2 \diamond^8 \diamond^{10} \diamond^6$ $aabla^3 abla^4 abla^5$ 09 Stop Freq 10.00000000 GHz CF Step 997.000000 MHz Man Start 30 MHz #Res BW 1.0 MHz Stop 10.000 GHz Sweep 18.67 ms (40001 pts) #VBW 3.0 MHz Auto dE 43.98 dBm 44.13 dBm 44.37 dBm 44.51 dBm 44.67 dBm 45.24 dBm Freq Offset 1 f 1 f 1 f 1 f 1 f 0 Hz 6.948 68 GHz 4.841 52 GHz 7.678 24 GHz 8.681 97 GHz 4.251 55 GHz dB STATUS

### Conducted Spurious Emissions 2 (TM 2 & Test Channel : Middle)

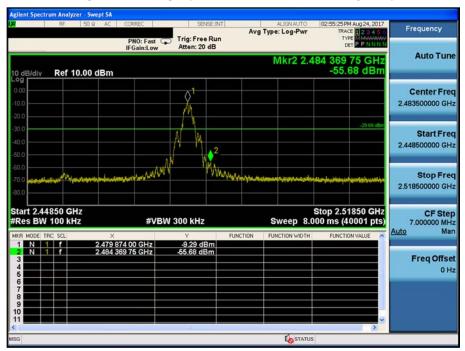
## Conducted Spurious Emissions 3 (TM 2 & Test Channel : Middle)

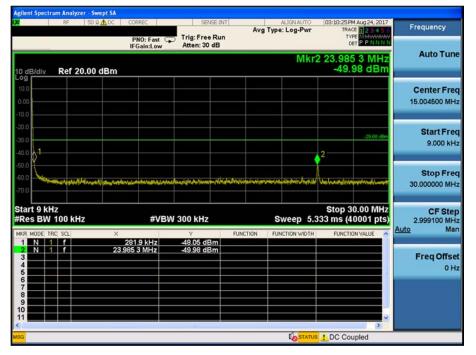
RF 50	PN	0: Fast	SENSE:1	Av	g Type: Log-Pwr	02:33:08 PM Aug 24, 201 TRACE 2 3 4 5 TVPE M	Frequency
dB/div Ref 20.00		ain:Low	Atten: 30 dB		Mkr7 1	1.072 875 GH -44.09 dBr	Z Auto Tune
							Center Free 17.500000000 GH
	<b>∂</b> <sup>6</sup>	\$ <sup>5</sup>	3	\$4	¢	-21.62.45	Start Free 10.000000000 GH
							Stop Fre 25.000000000 GH
art 10.000 GHz es BW 1.0 MHz		#VBW	3.0 MHz			Stop 25.000 GH .00 ms (40001 pt	
MODE TRC SCL	× 24.222 250	GHz	-33.76 dBm	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE	
N 1 F N 1 F N 1 F N 1 F	21.756 250 16.988 500 18.466 750 15.238 375 13.910 875	GHz GHz GHz	-36.22 dBm -39.01 dBm -39.12 dBm -40.75 dBm -41.45 dBm				Freq Offse 0 H
N 1 F	11.072 875		-44.09 dBm				
							~



#### Reference (TM 2 & Test Channel : Highest)

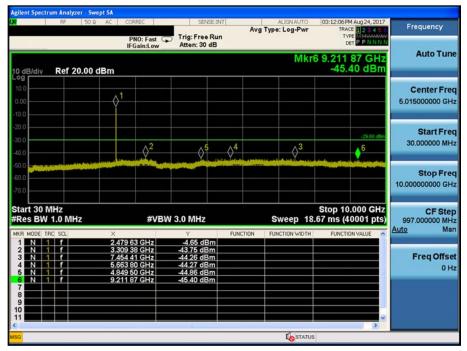
High Band-edge (TM 2 & Test Channel : Highest)





## Conducted Spurious Emissions 1 (TM 2 & Test Channel : Highest)

## Conducted Spurious Emissions 2 (TM 2 & Test Channel : Highest)



#### Frequency Avg Type: Log-Pwr PNO: Fast Trig: Free Run IFGain:Low Atten: 20 dB Auto Tune Mkr6 14.699 875 GHz -50.57 dBm Ref 10.00 dBm 10 dB/div Center Freq 17.50000000 GHz $\Delta^2$ Start Freq $\Diamond^3 \Diamond^5$ 6 $\Diamond^4$ 10.00000000 GHz Stop Freq 25.00000000 GHz Start 10.000 GHz #Res BW 1.0 MHz Stop 25.000 GHz Sweep 40.00 ms (40001 pts) CF Step 1.500000000 GHz .uto Man #VBW 3.0 MHz Auto 43.19 dBm 46.17 dBm 49.30 dBm 49.34 dBm 49.51 dBm 50.57 dBm N 1 f N 1 f N 1 f N 1 f N 1 f N 1 f 21.549 625 GHz 18.618 625 GHz 16.960 375 GHz 19.416 250 GHz 14.699 875 GHz Freq Offset 0 Hz STATUS

### Conducted Spurious Emissions 3 (TM 2 & Test Channel : Highest)

## 3.5 Unwanted Emissions (Radiated)

#### Test Requirements and limit,

#### §15.247(d), §15.205, §15.209 & RSS-247 [5.5], RSS-Gen [8.9], RSS-Gen [8.10]

In any 100 kHz bandwidth outside the operating frequency band. In case the emission

fall within the restricted band specified on 15.205(a) and (b), then the 15.209(a) limit in the table below has to be followed

#### - FCC Part 15.209(a) and (b)

Frequency (MHz)	Limit (uV/m)	Measurement Distance (meter)
0.009 ~ 0.490	2400/F (kHz)	300
0.490 ~ 1.705	24000/F (kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

\*\* Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 MHz, 76 ~ 88 MHz, 174 ~ 216 MHz or 470 ~ 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

• FCC Part 15.205 (a) : Only spurious emissions are permitted in any of the frequency bands listed below :

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.41425 ~ 8.41475	108 ~ 121.94	1300 ~ 1427	4.5 ~ 5.15	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1435 ~ 1626.5	5.35 ~ 5.46	15.35 ~ 16.2
2.1735 ~ 2.1905	12.51975 ~	149.9 ~ 150.05	1645.5 ~ 1646.5	7.25 ~ 7.75	17.7 ~ 21.4
4.125 ~ 4.128	12.52025	156.52475 ~	1660 ~ 1710	8.025 ~ 8.5	22.01 ~ 23.12
4.17725 ~ 4.17775	12.57675 ~	156.52525	1718.8 ~ 1722.2	9.0 ~ 9.2	23.6 ~ 24.0
4.20725 ~ 4.20775	12.57725	156.7 ~ 156.9	2200 ~ 2300	9.3 ~ 9.5	31.2 ~ 31.8
6.215 ~ 6.218	13.36 ~ 13.41	162.0125 ~ 167.17	2310 ~ 2390	10.6 ~ 12.7	36.43 ~ 36.5
6.26775 ~ 6.26825	16.42 ~ 16.423	167.72 ~ 173.2	2483.5 ~ 2500	13.25 ~ 13.4	Above 38.6
6.31175 ~ 6.31225	16.69475 ~	240 ~ 285	2655 ~ 2900		
8.291 ~ 8.294	16.69525	322 ~ 335.4	3260 ~ 3267		
8.362 ~ 8.366	16.80425 ~	399.90 ~ 410	3332 ~ 3339		
8.37625 ~ 8.38675	16.80475	608 ~ 614	3345.8 ~ 3358		
	25.5 ~ 25.67	960 ~ 1240	3600 ~ 4400		
	37.5 ~ 38.25				
	73 ~ 74.6				
	74.8 ~ 75.2				

• FCC Part 15.205(b) : The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.



### 3.5.1 Test Setup

Refer to the APPENDIX I.

#### 3.5.2 Test Procedures

- 1. The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m.
- 2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
- 3. EUT is set 1 or 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
- 4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
- 6. Repeat above procedures until the measurements for all frequencies are complete.

#### Note: Measurement Instrument Setting for Radiated Emission Measurements.

#### 1. Frequency Range: ≤ 1 GHz

RBW = 100 or 120 kHz, VBW = 3 x RBW, Detector = Peak or Quasi Peak

#### 2. Frequency Range: > 1 GHz

#### **Peak Measurement**

RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto, Trace mode = Max Hold until the trace stabilizes

#### Average Measurement

The result of Average measurement was calculated using PK result and duty cycle reduction factor. (The Peak measurement was performed at 100% duty cycle. But, this device has a low duty cycle when actual operation.)

Note: Refer to appendix II for duty cycle correction factor.



### 3.5.3 Test Results

#### Test Mode: TM 1

## Frequency Range : 9 kHz ~ 25 GHz

#### Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2389.70	V	Z	PK	46.83	0.70	N/A	N/A	47.53	74.00	26.47
2389.70	V	Z	AV	46.83	0.70	-33.98	N/A	13.55	54.00	40.45
4810.89	Н	Х	PK	46.60	4.80	N/A	N/A	51.40	74.00	22.60
4810.89	Н	Х	AV	46.60	4.80	-33.98	N/A	17.42	54.00	36.58

### Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4880.85	Н	Х	PK	45.68	5.10	N/A	N/A	50.78	74.00	23.22
4880.85	Н	Х	AV	45.68	5.10	-33.98	N/A	16.80	54.00	37.20

### Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.50	Н	Х	PK	64.03	0.94	N/A	N/A	64.97	74.00	9.03
2483.50	Н	Х	AV	64.03	0.94	-33.98	N/A	30.99	54.00	23.01
4960.93	Н	Х	PK	45.55	5.34	N/A	N/A	50.89	74.00	23.11
4960.93	Н	Х	AV	45.55	5.34	-33.98	N/A	16.91	54.00	37.09

#### Note.

1. The radiated emissions were investigated up to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3 m to 1 m. In this case, the distance factor(-9.54 dB) is applied to the result.

- Calculation of distance factor = 20 log( applied distance / required distance ) = 20 log( 1 m / 3 m ) = -9.54 dB

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

3. Sample Calculation.

Margin = Limit - Result / Result = Reading + T.F + D.C.F / T.F = AF + CL - AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,

DCF = Duty Cycle Correction Factor.



## Test Mode: TM 2

# Frequency Range : 9 kHz ~ 25 GHz

## Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2389.33	Н	Z	PK	47.88	0.70	N/A	N/A	48.58	74.00	25.42
2389.33	Н	Z	AV	47.88	0.70	-4.98	N/A	43.60	54.00	10.40
4811.12	Н	Х	PK	46.88	4.80	N/A	N/A	51.68	74.00	22.32
4811.12	Н	Х	AV	46.88	4.80	-4.98	N/A	46.70	54.00	7.30

### Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4881.10	Н	Х	PK	47.77	5.10	N/A	N/A	52.87	74.00	21.13
4881.10	Н	Х	AV	47.77	5.10	-4.98	N/A	47.89	54.00	6.11

### Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.50	V	Х	PK	56.27	0.94	N/A	N/A	57.21	74.00	16.79
2483.50	V	Х	AV	56.27	0.94	-4.98	N/A	52.23	54.00	1.77
4961.04	Н	Х	PK	47.14	5.34	N/A	N/A	52.48	74.00	21.52
4961.04	Н	Х	AV	47.14	5.34	-4.98	N/A	47.50	54.00	6.50

#### Note.

1. The radiated emissions were investigated up to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3 m to 1 m. In this case, the distance factor(-9.54 dB) is applied to the result.

- Calculation of distance factor = 20 log( applied distance / required distance ) = 20 log( 1 m / 3 m ) = -9.54 dB

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

#### 3. Sample Calculation.

#### Test Mode: TM 3

## Frequency Range : 9 kHz ~ 25 GHz

### Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2389.40	V	Z	PK	47.82	0.70	N/A	N/A	48.52	74.00	25.48
2389.40	V	Z	AV	47.82	0.70	-33.98	N/A	14.54	54.00	39.46
4808.83	Н	Х	PK	46.41	4.80	N/A	N/A	51.21	74.00	22.79
4808.83	Н	Х	AV	46.41	4.80	-33.98	N/A	17.23	54.00	36.77

#### Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4880.88	Н	Х	PK	45.59	5.10	N/A	N/A	50.69	74.00	23.31
4880.88	Н	Х	AV	45.59	5.10	-33.98	N/A	16.71	54.00	37.29

#### Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.51	Н	Х	PK	63.82	0.94	N/A	N/A	64.76	74.00	9.24
2483.51	Н	Х	AV	63.82	0.94	-33.98	N/A	30.78	54.00	23.22
4960.88	Н	Х	PK	45.18	5.34	N/A	N/A	50.52	74.00	23.48
4960.88	Н	Х	AV	45.18	5.34	-33.98	N/A	16.54	54.00	37.46

#### Note.

1. The radiated emissions were investigated up to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3 m to 1 m. In this case, the distance factor(-9.54 dB) is applied to the result.

- Calculation of distance factor = 20 log( applied distance / required distance ) = 20 log( 1 m / 3 m ) = -9.54 dB

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

#### 3. Sample Calculation.



#### Test Mode: TM 4

## Frequency Range : 9 kHz ~ 25 GHz

## Lowest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2389.81	Н	Z	PK	46.74	0.70	N/A	N/A	47.44	74.00	26.56
2389.81	Н	Z	AV	46.74	0.70	-4.98	N/A	42.46	54.00	11.54
4811.25	Н	Х	PK	47.15	4.80	N/A	N/A	51.95	74.00	22.05
4811.25	Н	Х	AV	47.15	4.80	-4.98	N/A	46.97	54.00	7.03

#### Middle Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
4881.27	Н	Х	PK	48.46	5.10	N/A	N/A	53.56	74.00	20.44
4881.27	Н	Х	AV	48.46	5.10	-4.98	N/A	48.58	54.00	5.42

### Highest Channel

Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	D.C.F (dB)	Distance Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2483.50	V	Х	PK	55.54	0.94	N/A	N/A	56.48	74.00	17.52
2483.50	V	Х	AV	55.54	0.94	-4.98	N/A	51.50	54.00	2.50
4961.00	Н	Х	PK	47.35	5.34	N/A	N/A	52.69	74.00	21.31
4961.00	Н	Х	AV	47.35	5.34	-4.98	N/A	47.71	54.00	6.29

#### Note.

1. The radiated emissions were investigated up to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.

2. Information of Distance Factor

For finding emissions, the test distance might be reduced from 3 m to 1 m. In this case, the distance factor(-9.54 dB) is applied to the result.

- Calculation of distance factor = 20 log( applied distance / required distance ) = 20 log( 1 m / 3 m ) = -9.54 dB

When distance factor is "N/A", the distance is 3 m and distance factor is not applied.

#### 3. Sample Calculation.



## 3.6 Power line Conducted Emissions

#### Test Requirements and limit, §15.207 & RSS-Gen [8.8]

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 50  $\mu$ H/50 ohms line impedance stabilization network (LISN).

	Conducted Limit (dBuV)				
Frequency Range (MHz)	Quasi-Peak	Average			
0.15 ~ 0.5	66 to 56 *	56 to 46 *			
0.5 ~ 5	56	46			
5 ~ 30	60	50			

\* 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.

#### 3.6.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

#### 3.6.2 Test Procedures

Conducted emissions from the EUT were measured according to the ANSI C63.10.

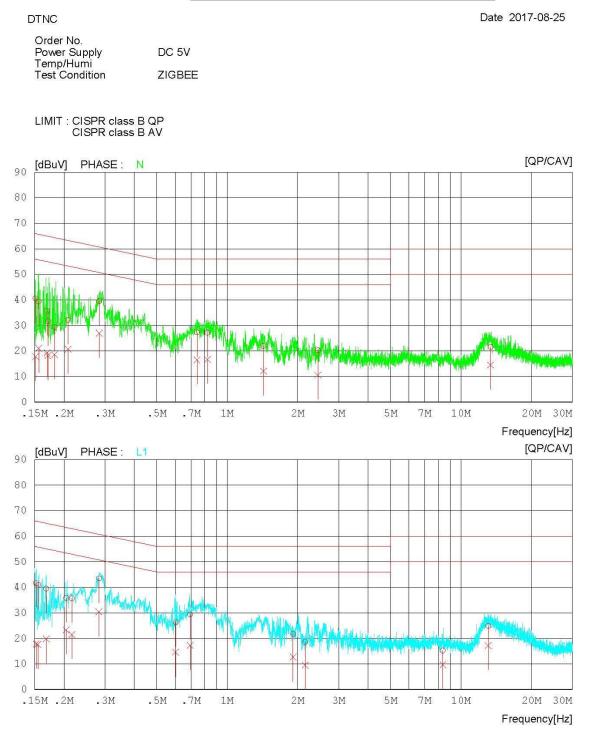
- The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
- 2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
- 3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
- 4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

Note: The worst data TM 3 was reported. Refer to the next page.

### 3.6.3 Test Results

## AC Line Conducted Emissions (Graph) = TM 1 & Test Channel : Middle

# **Results of Conducted Emission**



Date 2017-08-25

## AC Line Conducted Emissions (List) = TM 1 & Test Channel : Middle

# **Results of Conducted Emission**

DTNC

Order No. Power Supply E Temp/Humi Test Condition Z

DC 5V ZIGBEE

LIMIT : CISPR class B QP CISPR class B AV

NC	~	QP CAV			QP	CAV		PHASE
1	0.15135	30.51 7.80	10.04	40.55 17.84	65.93	55.93	25.3838.09	N
2		29.25 11.05	10.03	39.28 21.08	65.66	55.66	26.3834.58	N
3	0.16992	25.64 9.27	10.02	35.66 19.29	64.96	54.96	29.3035.67	Ν
4	0.17097	21.61 8.09	10.02	31.63 18.11	64.91	54.91	33.2836.80	N
5	0.18268	19.32 8.63	10.01	29.33 18.64	64.36	54.36	35.0335.72	Ν
6	0.20849	22.23 10.78	9.99	32.22 20.77	63.27	53.27	31.0532.50	Ν
7	0.28356	29.5516.94	10.00	39.55 26.94	60.71	50.71	21.1623.77	Ν
8	0.74269	17.29 6.48	10.02	27.31 16.50	56.00	46.00	28.6929.50	Ν
9	0.82420	17.17 6.72	10.03	27.20 16.75	56.00	46.00	28.80 29.25	Ν
10	1.42980	11.82 2.08	10.07	21.89 12.15	56.00	46.00	34.11 33.85	Ν
11	2.44120	10.07 0.44	10.13	20.20 10.57	56.00	46.00	35.80 35.43	N
12	13.39280	11.14 4.04	10.50	21.64 14.54	60.00	50.00	38.3635.46	Ν
13	0.15213	31.54 7.68	10.04	41.58 17.72	65.88	55.88	24.3038.16	L1
14	0.15507	30.85 7.56	10.03	40.88 17.59	65.72	55.72	24.84 38.13	L1
15	0.16812	29.40 9.70	10.02	39.42 19.72	65.05	55.05	25.6335.33	L1
16	0.20449	25.81 13.27	9.99	35.80 23.26	63.43	53.43	27.6330.17	L1
17	0.21661	25.62 11.48	9.99	35.61 21.47	62.95	52.95	27.34 31.48	L1
18	0.28259	33.33 20.37	10.00	43.33 30.37	60.74	50.74	17.41 20.37	L1
19	0.60274	16.15 4.57	10.03	26.18 14.60	56.00	46.00	29.8231.40	L1
20	0.69409	19.22 7.26	10.02	29.24 17.28	56.00	46.00	26.7628.72	L1
21		11.55 2.48		21.66 12.59	56.00	46.00	34.34 33.41	L1
22	2.15520	8.36-0.65		18.47 9.46	56.00	46.00	37.5336.54	L1
23	8.36440			15.15 9.69	60.00	50.00	44.8540.31	L1
24	13.08620	14.38 6.63	10.48	24.86 17.11	60.00	50.00	35.14 32.89	L1



## 3.7 Occupied Bandwidth

#### Test Requirements, RSS-Gen [6.6]

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99 % emission bandwidth, as calculated or measured.

### 3.7.1 Test Setup

Refer to the APPENDIX I.

#### 3.7.2 Test Procedures

The 99 % power bandwidth was measured with a calibrated spectrum analyzer.

The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3 × RBW.

Spectrum analyzer plots are included on the following pages.

#### 3.7.3 Test Results

Test Mode	Tested Channel	Test Results (MHz)
	Lowest	2.622
TM 1	Middle	2.627
	Highest	2.629
	Lowest	2.615
TM 2	Middle	2.632
	Highest	2.609







#### Occupied Bandwidth (99 %)

#### TM 1 & Test Channel : Middle



TM 1 & Test Channel : Highest



🛈 Dt&C

## TM 2 & Test Channel : Lowest



#### Occupied Bandwidth (99 %)

### TM 2 & Test Channel : Middle



TM 2 & Test Channel : Highest



## 4. ANTENNA REQUIREMENTS

#### According to FCC 47 CFR §15.203 & RSS-Gen [8.3]

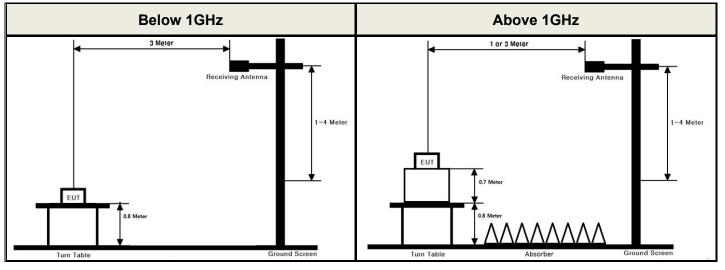
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient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

The internal antenna employs a unique antenna connector. Therefore this E.U.T Complies with the requirement of §15.203

## **APPENDIX I**

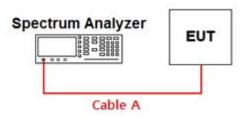
#### Test set up diagrams

Radiated Measurement



For measurement below 30MHz, the proper calibration between the chamber and OATS has been done per KDB 937606.

#### Conducted Measurement



#### Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	0.20	15	5.36
1	1.14	20	6.45
2.405 & 2.440 & 2.480	1.70	25	6.24
5	2.66	-	-
10	4.16	-	-

Note 1: The path loss from EUT to Spectrum analyzer was measured and used for test.

Path loss (S/A's correction factor) = Cable A (Attenuator, Applied only when it was used externally)



## **APPENDIX II**

## **Duty cycle**

#### Test Procedure

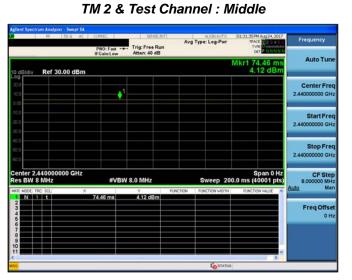
#### Duty Cycle was measured using section 6.0 b) of KDB558074 :

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.)

TM 1 & Test Channel : Middle





		Measured duty cycle under testing condition	100%
TM #2)	1(Modem	Declared the max duty cycle under normal operating condition (Transmit on time / period)	2.0% (1ms / 50 ms)
		Duty cycle reduction factor	20 x log (1ms/50ms) = -33.98 dB
		Measured duty cycle under testing condition	100%
TM #4)	2(Modem	Declared the max duty cycle under normal operating condition (Transmit on time / period)	56.3 % (4ms / 7.1ms)
		Duty cycle reduction factor	20 x log (4ms/7.1ms) = -4.98 dB

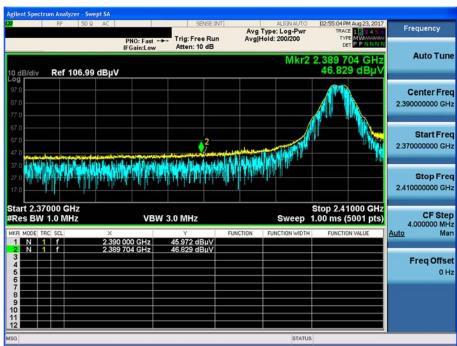
Note: The worst case duty cycle has heen provided by the manufacturer's technical documentation.

**Detector Mode : PK** 

## **APPENDIX III**

## **Unwanted Emissions (Radiated) Test Plot**

#### TM 1 & Lowest & Z & Ver

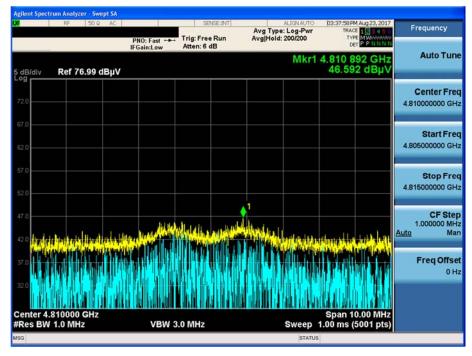


#### TM 1 & Highest & X & Hor

#### Frequency Avg Type: Log-Pwr Avg|Hold: 200/200 Trig: Free Run Atten: 20 dB PNO: Fast Auto Tun Mkr2 2.483 500 0 GHz 64.026 dBµV Ref 116.99 dBµV Center Freq 2.489000000 GHz Start Freq 2.478000000 GHz Th# Stop Freq tii P 2.50000000 GHz Stop 2.50000 GHz Start 2.47800 GHz #Res BW 1.0 MHz CF Step 2.200000 MHz Man VBW 3.0 MHz Sween 1.00 ms (5001 pts) Auto 2.483 500 0 GHz 2.483 500 0 GHz 64.026 dBµ\ 64.026 dBµ\ **Freq Offset** 0 Hz STATUS



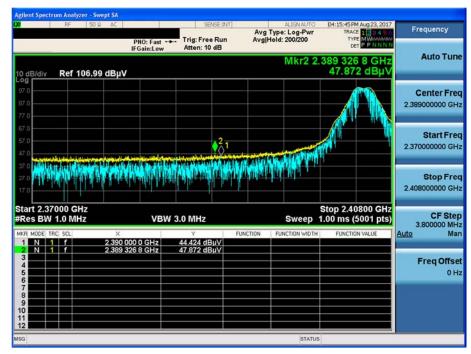
#### TM 1 & Lowest & X & Hor





#### TM 2 & Lowest & Z & Hor

#### **Detector Mode : PK**



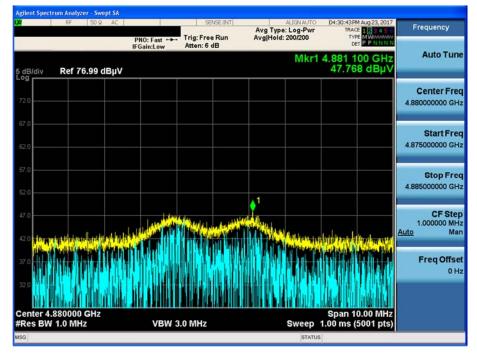
#### TM 2 & Highest & X & Ver

#### Frequency Avg Type: Log-Pwr Avg|Hold: 200/200 PNO: Fast Trig: Free Run Atten: 20 dB MWMM Auto Tune Mkr2 2.483 504 4 GHz 56.262 dBµV Ref 116.99 dBµV Center Freq 2.489000000 GHz Start Freq 2.478000000 GHz anan dahar mandaran kanan sarah sahar manan sahar dahar sarah yan sarah Stop Freq 2.50000000 GHz Start 2.47800 GHz #Res BW 1.0 MHz Stop 2.50000 GHz 1.00 ms (5001 pts) CF Step 2.200000 MHz Man VBW 3.0 MHz Sweep Auto 2.483 500 0 GHz 2.483 504 4 GHz 55.899 dBµV 56.262 dBµV Freq Offset 0 Hz



#### TM 2 & Middle & X & Hor

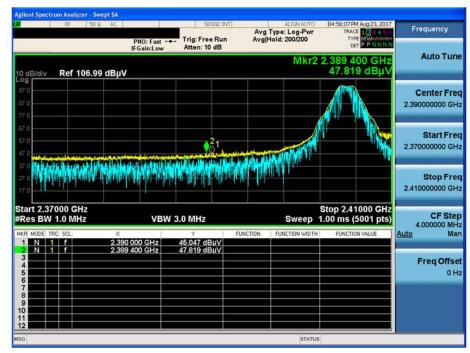
## Detector Mode : AV



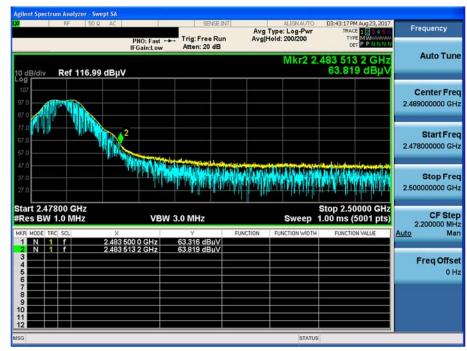


#### TM 3 & Lowest & Z & Ver

#### **Detector Mode : PK**



#### TM 3 & Highest & X & Hor





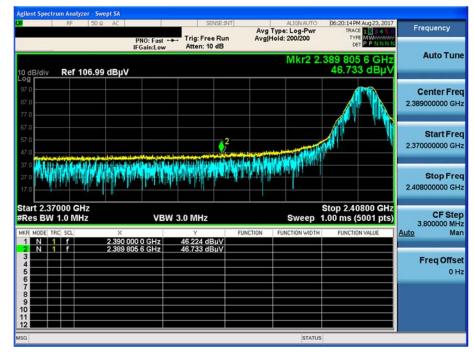
#### TM 3 & Lowest & X & Hor

#### yzer - Swept SA Frequency TRACE Avg Type: Log-Pwr Avg|Hold: 200/200 PNO: Fast ++- Trig: Free Run IFGain:Low Atten: 6 dB DET Auto Tune Mkr1 4.808 830 GHz 46.404 dBµV Ref 76.99 dBµV dB/di **Center Freq** 4.81000000 GHz Start Freq 4.80500000 GHz Stop Freq 4.815000000 GHz CF Step 1.000000 MHz Man Auto Freq Offset 0 Hz Center 4.810000 GHz #Res BW 1.0 MHz Span 10.00 MHz Sweep 1.00 ms (5001 pts) VBW 3.0 MHz



#### TM 4 & Lowest & Z & Hor

#### **Detector Mode : PK**



#### TM 4 & Highest & X & Ver

#### er - Swent SA Frequency Avg Type: Log-Pwr Avg|Hold: 200/200 Trig: Free Run Atten: 20 dB DET PNO: Fast Auto Tune Mkr2 2.483 500 0 GHz 55.537 dBµ\ Ref 116.99 dBµV **Center Freq** 2.489000000 GHz Start Freq 2.478000000 GHz THE DOLLAR DE CONTRACTORIST Stop Freq 2.50000000 GHz Stop 2.50000 GHz 1.00 ms (5001 pts) CF Step 2.200000 MHz Man Start 2.47800 GHz #Res BW 1.0 MHz VBW 3.0 MHz Sweep Auto 2.483 500 0 GHz 2.483 500 0 GHz 55.537 dBµV 55.537 dBµV **Freq Offset** 0 Hz 12 STATUS



#### TM 4 & Middle & X & Hor

#### **Detector Mode : AV**

